SEPTEMBER 25, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

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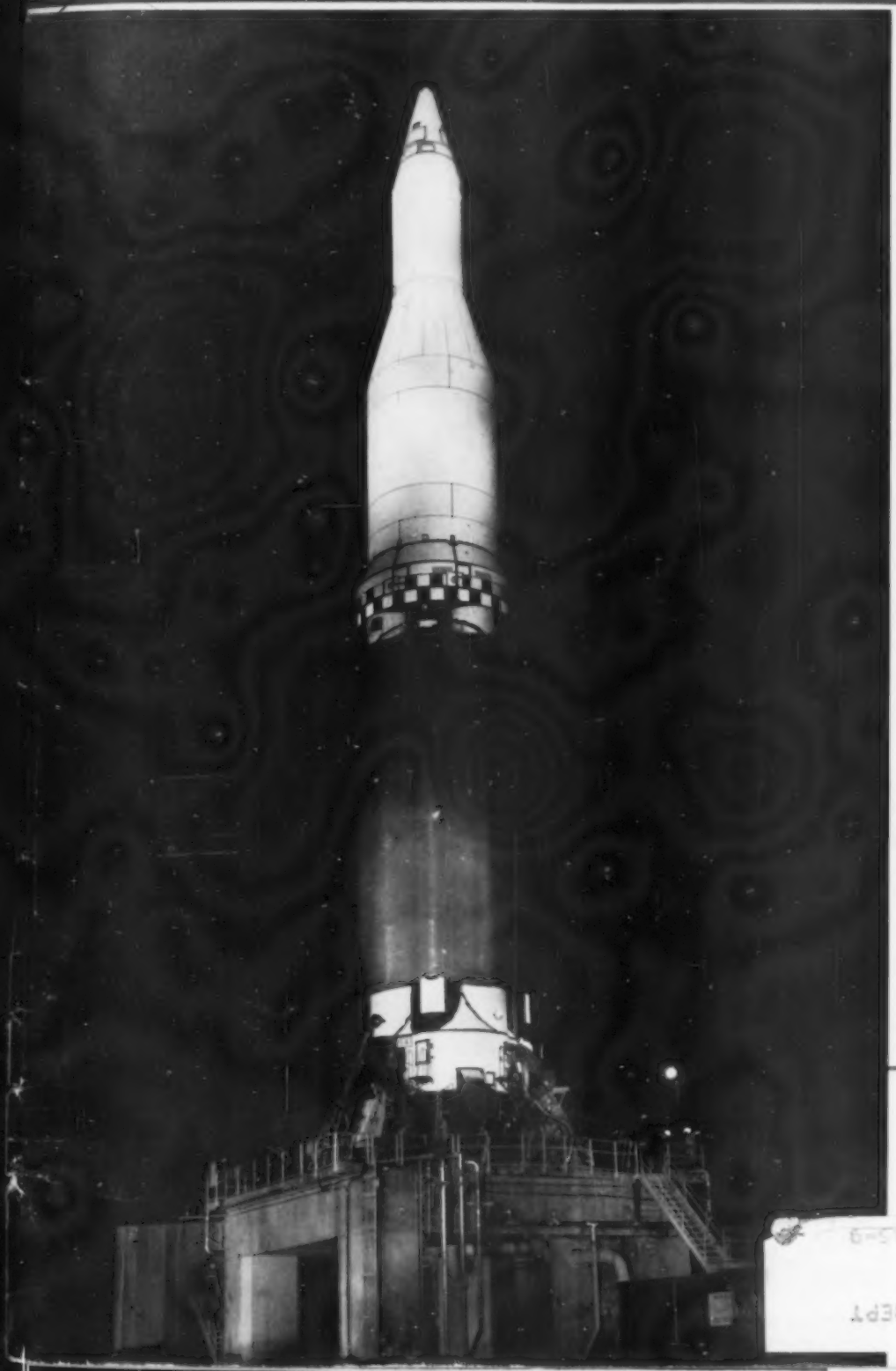

Special M/R Report On Scope of Electronic Warfare

- Delays Snarl Nuclear Program
- AF Overhauls Its Code Names
- NASA Ponders Saturn Speed-up

Gantryless Saturn at Cape

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THERMOPLASTIC RECORDER/DISPLAY SYSTEM

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At 40,000 feet and higher a pilot could spot ground-level targets no larger than a tank by using a new recorder/display system developed by General Electric's Light Military Electronics Department. A photographic view is obtained from side-looking radar, recorded on thermoplastic tape, and displayed instantly on a screen in the cockpit. Requiring no cathode ray tube, the screen has variable brightness that permits operation in ambient light, without the use of a hood.

At extreme heights—or in space—the system is capable of providing great detail and a permanent data record of TV, infrared, or any other "eyes" of the vehicle. Combined or composite displays are also possible for integrated display applications. The thermoplastic recorder/display system is a typical example of LMED contributions to progress in aero/space electronics. 150-07

GENERAL ELECTRIC

Light Military Electronics Department

Utica, New York

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"Whither goest thou, and by what guidance?" spoke the great Persian astronomer, Nassir-Eddin Al Tusi to Marco Polo, as the Venetian announced his adventure to the Far East in 1271. The astronomer's advice was simple and direct: "Knowest thou the stars." What better advice for today's explorers? What better guidance system than knowledge itself, as we step off the earth's edge.

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SOME USERS OF THE MUSSER "COPERNICAN" PLANETARIUM... Douglas Aircraft Company, Aero/Astrodynamics Section, Missiles and Space Systems (For demonstrating interplanetary trajectory requirements); Jet Propulsion Laboratory. (For preliminary measurements of spacecraft and planetary relationships, and earth-to-spacecraft communications); American Museum-Hayden Planetarium. (For teaching 19 courses in astronomy and celestial navigation); Adler Planetarium and Astronomical Museum (For demonstrating solar system mechanics and movement of the night sky, in 5 or 6 public lectures daily.)

Beneath a field like this...

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In minutes, an enemy attack could level some of our sprawling cities.

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Yet, the Bell System recognizes that communications are the lifelines of our defense systems. And so we took the lead in establishing these underground centers with our own money.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 13 September 25, 1961

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THE COVER

First Saturn C-1 at Cape Canaveral waits for scheduled launching in week of Oct. 9. This is first photo showing the 163-ft. vehicle with gantry pulled back. *See p. 16.*

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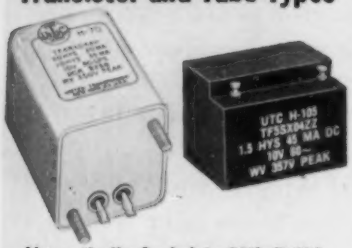

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memo from the publisher

AT LEAST FIFTY CENTS of every dollar spent for missile and space systems goes into electronic equipment and components. Over the next ten years, as the National Aeronautics and Space Administration's *Apollo* program and follow-on projects become a reality, this ratio is likely to increase.

For the past three years, M/R Electronics Editor Charlie LaFond has been spending at least fifty percent of his time (and sometimes, it seems, fifty percent of our money) traveling throughout the United States to cover missile/space electronics.

Even more impressive than the many thousands of miles he has traveled for M/R, however, has been Charlie's productive pen. Nearly every issue of our publication during the past several years has carried at least one technical article over his byline, the majority of which have stimulated orders for some of the more-than-400,000 reprints we've turned out during this period. We believe that the missile/space industry now recognizes this man as one of its outstanding and most capable technical writers.

We are happy to announce, therefore, the appointment of Charles LaFond as Senior Editor, following by just two months the appointment of M/R Military Affairs Editor Jim Baar to the same post.

LaFond is uniquely qualified in the area of missile/space electronics. In addition to studying electrical engineering at Catholic University and the Capitol Radio Engineering Institute, Charlie spent three years in the U.S. Army during and after World War II, attending no less than six military technical schools, including three in the communications field.

Before joining M/R, Charlie gleaned a wealth of information and experience from four electronics writing jobs in industry, including three years at Page Communications Engineers here in Washington, where he helped direct the preparation of all company publications and authored no less than nine technical books for long-range scatter communications systems.

LaFond has scattered his club affiliations as well, being a current member of IRE, ARS, AAS, NRC, NAC and AFCEA. If memory serves me correctly, all these impressive initials stand for Institute of Radio Engineers, American Rocket Society, American Astronautical Society, National Rocket Club, National Aviation Club and Armed Forces Communications and Electronics Association.

SENIOR EDITOR LaFond.

Between society and club meetings and his writing assignments on M/R, Charlie has found time to marry one of the most charming young ladies ever to leave English soil. He and Anne LaFond and their young daughter, Linda, live in Silver Spring, Maryland, where Charlie spends much of his practically nonexistent spare time planning a book on the subject of missile/space optics.

* * * * *

LaFond's appointment as our second Senior Editor is the harbinger of things to come in expanded M/R coverage of missile/space electronics. We soon will place electronics editors in our New York and Los Angeles offices to provide more and even better coverage of one of the industry's most important and most problematical subjects.

* * * * *

All of us here on the M/R staff have our hands full right now planning M/R's first Special Issue on NASA, to be published on November 27th of this year. With full cooperation from NASA headquarters, M/R editors will be visiting NASA installations throughout the nation during the next two months. Then, on November 27th, your morning mail will bring you the very latest run-down on NASA's programs and projects, facilities, budget, personnel, and contracting procedures. Watch for this Special Issue and remember the date: November 27th. It will be the most complete guide to NASA yet published. ¤

Edward Mukerfeld

—letters—

Anti-Gravity

To the Editor:

The title, "Practical Anti-Gravity Still Far Off" (M/R, Sept. 11, p. 28) would more appropriately be "Theoretical Anti-Gravity Still Far Off." The author of the article would be well advised to examine or re-examine Einstein's Unified Field Theory and his (the author's) denunciation of it before he attempts another elementary analogy between gravitational and electrical fields.

Jerry Dean
Rockledge, Fla.

The author of the article, Robert L. Forward of the University of Maryland Physics Dept., replies:

The analogies between gravitational and electromagnetic fields are well known to theorists in General Relativity (C. Moller, "The Theory of Relativity," pp. 246 and 291; J. Weber, "General Relativity and Gravitational Waves," pp. 159-161, and others).

The particular equations used in this article were taken from the paper, "General Relativity for the Experimentalist," Proc. IRE, Vol. 49, May, 1961. A reprint will be sent to Mr. Dean.

If this particular method of obtaining anti-gravity is not acceptable, then there are at least three other, basically different ways to generate gravitational forces, using Einstein's Theory of General Relativity. (All unfortunately are as impractical as the model in the article.)

For example, from J. Weber's book, p. 160, if you are inside a stationary massive sphere, there are no forces. If the sphere starts rotating, then according to Einstein's Theory of General Relativity, you will experience gravitational forces that will tend to lift you into the plane of rotation.

Water Cost Spirals

To the Editor:

The article "U.S. Seeks Oceanography Instruments" (M/R, Aug. 28, p. 22) states that it costs $16.30 to obtain a liter of water, and that this is equivalent to $11.70 a fifth.

Actually, as it appears to me, it would cost slightly more per fifth. Since one gallon is 3.785 liters (as in ITT's Reference Data for Radio Engineers, 4th Edn.) the cost of one gallon would be $61.70; hence the cost of one-fifth gallon is $12.34.

G. A. Sabin
Orlando, Fla.

Building Ladies, Bless 'Em

To the Editor:

As a fascinated reader of M/R, I would like to bring to your attention the fact that there are many women now engaged in the construction industry. To point up this fact, Atlanta has organized a branch of Women in Construction.

(Continued on page 53)

Talk with the leaders in high-energy fuel production and research...

at Booth 546, ARS "Space Flight Report to the Nation" New York Coliseum, October 9 through 15.

Callery Chemical Company, pioneers in the boron propellant field, continue an active research, development and production program on high-energy materials of the solid, liquid and hybrid types. New concepts of energy for outer space are also under study.

Callery engineers will be on hand at Booth 546 at the New York ARS show, to talk with you about developments in all phases of propellant research, applications and evaluation.

If you can't make the show, be sure to get the latest information from the Callery laboratories. Fill in and return the coupon below, clipped to your letterhead.

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The Countdown

WASHINGTON

A Big Boost for Solids

Plans for moving ahead with R&D of a solid superbooster now are expected to emerge shortly from the joint DOD-NASA committee which has been studying various proposals. Air Force and industry sources are optimistic that the solid superbooster can be developed considerably sooner than the big liquid *Nova*.

Fall Outlook: More Fall-Out

Watch for an announcement that the U.S. will resume nuclear testing in the atmosphere. The Defense Department is pressing for it—hard. Two of the key requirements: Testing of antimissile missiles and establishment of new parameters for hardened missile sites.

Major Missile Decisions Ahead

The Kennedy Administration will be making major decisions within the next few weeks on a number of missile and aircraft programs. This will include a decision on the fate of the mobile *Minuteman* program. Meanwhile, Boeing's research and development contract for the railroad car-mounted *Minuteman* is being extended for a minimum period—three months—at a cost of about $15 million.

Changes in House Space Committee

Subcommittees of the House Space Committee will get more responsibility under the new committee chairman, Rep. George P. Miller of California (see p. 11). He is expected to allow the subcommittees to specialize in various scientific fields, laying to rest an objection of many members that opportunities were lacking to acquaint themselves with technical details of the space effort. Miller's Eighth California district, incidentally, lies along the east shore of San Francisco Bay, an area burgeoning with Space Age industrial firms.

How Big is Big?

Pentagon brass hats still are debating the significance of Russia's boast it is developing a 100-megaton bomb. Defense Secretary McNamara says it is more a terror weapon than a military threat. But some military men contend the 100-megaton warhead gives added value to the *Polaris* weapon system and undercuts to some extent the survival chances of presently-planned fixed *Minutemen*.

Still More Jobs at NASA

NASA soon will open recruiting offices in New York, Los Angeles and Dallas as part of its drive to round up some 2400 new employees, including 1500 engineers and scientists, by June 30, 1962.

INDUSTRY

Siegler V.P. Tapped

Siegler Corp.'s corporate vice president, John J. Burke, is slated for a top NASA post. NASA Administrator Webb will make the announcement himself shortly. Burke, who joined Siegler in 1956, formerly was executive vice president of Hallamore Division at Anaheim, Calif. Prior to that he was with Jet Propulsion Laboratory for nine years. He is a Cal Tech graduate.

Happy Future for GE

If the future of precise inertial guidance and navigation in space lies with cryogenics, then General Electric appears to be rolling in clover. The company now has four major contracts in the field: one Army, one Navy and two NASA. Through its own investment in cryogenic R&D, the company also holds ten basic patents for cryogenic systems, devices and applications.

Problem for Dyna-Soar

One of the toughest problems confronting engineers working on *Dyna-Soar* is that of assuring continuous communications. The spacecraft is threatened with an ionization communications blackout during several phases of its flight path.

No Presidential Pressure

Although representatives of several states denounced NASA's selection of Houston, Tex., for the big new space lab as a political choice, Administrator Webb rested secure in the knowledge that President Kennedy wouldn't be complaining on behalf of Massachusetts. He had assurances from the President to that effect.

More Money for Boron

Air Force is estimating cost of a new applied research effort on boron fuels at approximately $1.5 million during the coming year. The program is to be carried out at the Muskogee, Okla., plant operated by Callery Chemical Co. Several rocket firms are expected to bid on the high-energy program.

Follow-on for Dyna-Soar

Military follow-on to the *Dyna-Soar* vehicle has been tagged *Dyna-Mows (Manned Orbital Weapons System)*. Two subcontract teams are working on competitive designs under Boeing direction. It will be larger than *Dyna-Soar*.

INTERNATIONAL

Indian Space Program

India now plans to build up its "big nation" image by establishing a rocket and space program. A Lockheed scientist is on his way to the Physical Research Laboratory at Ahmedabad, near Bombay, to assist in the programing.

Japan Plans Rocket R&D

Some $24.4 million for R&D work in hypersonic flight, rockets and VTOL/STOL aircraft is being requested by the Japanese Science and Techonology Agency. The five-year program calls for research facilities for ramjet engines and for a rocket engine test bed.

The Missile/Space Week

Holmes Sees Major Job As Integrating Effort

New *Apollo* project director D. Brainerd Holmes believes the biggest problem he faces in the manned lunar program is one of integration.

The RCA official told M/R after his appointment last week that the toughest part of his job will be "integrating the vast numbers of people, industry and government agencies into one common effort as soon as possible."

Holmes, as Director of Manned Space Flight Programs, will report only to NASA Administrator James E. Webb and Associate Administrator Robert C. Seamans, Jr. He will be responsible for direct supervision of NASA's accelerating and expanding manned space flight activities—at NASA centers and in industry, the space agency announcement said.

Meanwhile, it was learned that further changes in NASA organization are in store as it moves to gear up for the *Apollo* program. Other new program offices will be set up, and there will be some shifting of activities and responsibilities from the current setup to the new Manned Space Flight office.

It was also learned that the new *Apollo* management group will have some 300 employees and will be located in Washington.

Holmes—currently General Manager, Major Defense Systems Div., at RCA Defense Electronic Products—will assume his new position Nov. 1.

As Project Manager for Ballistic Missile Early Warning System (BMEWS) for RCA, the system contractor, he was responsible for coordinating for the Air Force a vast effort embracing the government and some 2900 US firms.

Shots of the Week

A Soviet missile with a high-precision control system was fired 7500 mi. into the Central Pacific on Sept. 17. It was the second shot in the current series, scheduled to last until mid-October. The first missile was launched on Sept. 14. Tass said the initial shot landed less than one kilometer (1094 yds.) from the target and that the second was in the same vicinity.

The Pacific impact area, bordered by the Marshall Islands to the west, Palmyra island to the east, Johnston Island to the north and Baker Island to the south, is 200 to 500 mi. shorter than the range of last year's Soviet firings. This has led to speculation that purpose of the shots is to test control system accuracy, rather than maximum range.

Soviet tracking ships are in the area. Moscow speculation suggested the tests might be a prelude to a new Soviet lunar firing.

Successes and failures meanwhile continued to mark U.S. launch attempts:

- The Air Force failed on Sept. 19 in its attempt to recover the *Discoverer XXXI* capsule, loaded with space radiation experiments. Capsule and satellite, launched Sept. 17, failed to separate and both remained in orbit.
- *Discoverer XXX* capsule, launched Sept. 13, was recovered the following day in a mid-air snatch by an Air Force C-130 near Hawaii. It also carried radiation experiments.
- On Sept. 19, a *Bomarc B* launched on command by the SAGE center at Montgomery, Ala., intercepted and destroyed a supersonic *Regulus II* over the Gulf of Mexico. The *Regulus* was launched from Venice, Fla., the Boeing-built *Bomarc B* from Eglin AFB, Fla.
- Scheduled firing of a Martin *Titan* from Vandenberg AFB, Calif., was cancelled on Sept. 19 for the second time within a week. Within five minutes of launch, the countdown was scrubbed for "technical" reasons. No rescheduling was announced.
- A two-stage Martin *Pershing* was fired on Sept. 13 from its mobile transporter-erector-launcher (TEL) at Cape Canaveral. The Army said all test objectives were met, including a test of the inertial guidance system.
- Army's firing of a *Nike-Zeus* at White Sands Missile Range on Sept.

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15 also met all test objectives, according to official spokesmen. Launch was a controlled high-velocity test within the atmosphere during which the missile responded to control commands from the ground guidance center. Other objectives included further evaluation of the solid-fuel rocket motors and electronic guidance system.

• On Sept. 17, French and NASA scientists launched a *Nike Asp* rocket from Wallops Island, Va., in one of a series of spectacular tests releasing sodium and lithium vapor clouds at altitude. Payload contained 13.5 lbs. of thermite and 4.5 lbs. of sodium and lithium pellets. Ignition of the thermite by an electrical charge vaporized the pellets which then exhausted from a stainless-steel cylinder. The vapor, initially ejected at an altitude of 38 mi., extended to a peak altitude of 129 mi., appearing as glowing orange and pink clouds in the upper atmosphere.

STRAC and TAC Merged

Defense Secretary Robert McNamara last week announced amalgamation of the three-division Strategic Army Corps (STRAC) and the Tactical Air Command (TAC) into a unified command.

Miller Strong Space Backer

Rep. George P. Miller (D-Calif.), new chairman of the House Space committee, is expected to support a stepped-up U.S. space program.

Congressional sources report that Rep. Miller, who fills the vacancy created by the death of Rep. Overton Brooks (D-La.), has consistently voted for the space programs of both the Eisenhower and Kennedy administrations.

Flickinger Sees 30-yr. Gap

Just back from a trip to the Soviet Union, Brig. Gen. Don H. Flickinger (USAF, Ret.) takes a gloomy view of U.S. chances of catching the Soviet Union in manned space flight.

One of the nation's top space medicine experts, and until a few weeks ago Bio-Astronautics Deputy to the Air Force Systems Commander, Gen. Flickinger predicts it will take 30 years to catch up with the Russians in this field. He proposes that all U.S. space organizations be combined into a fourth military service to get the job done.

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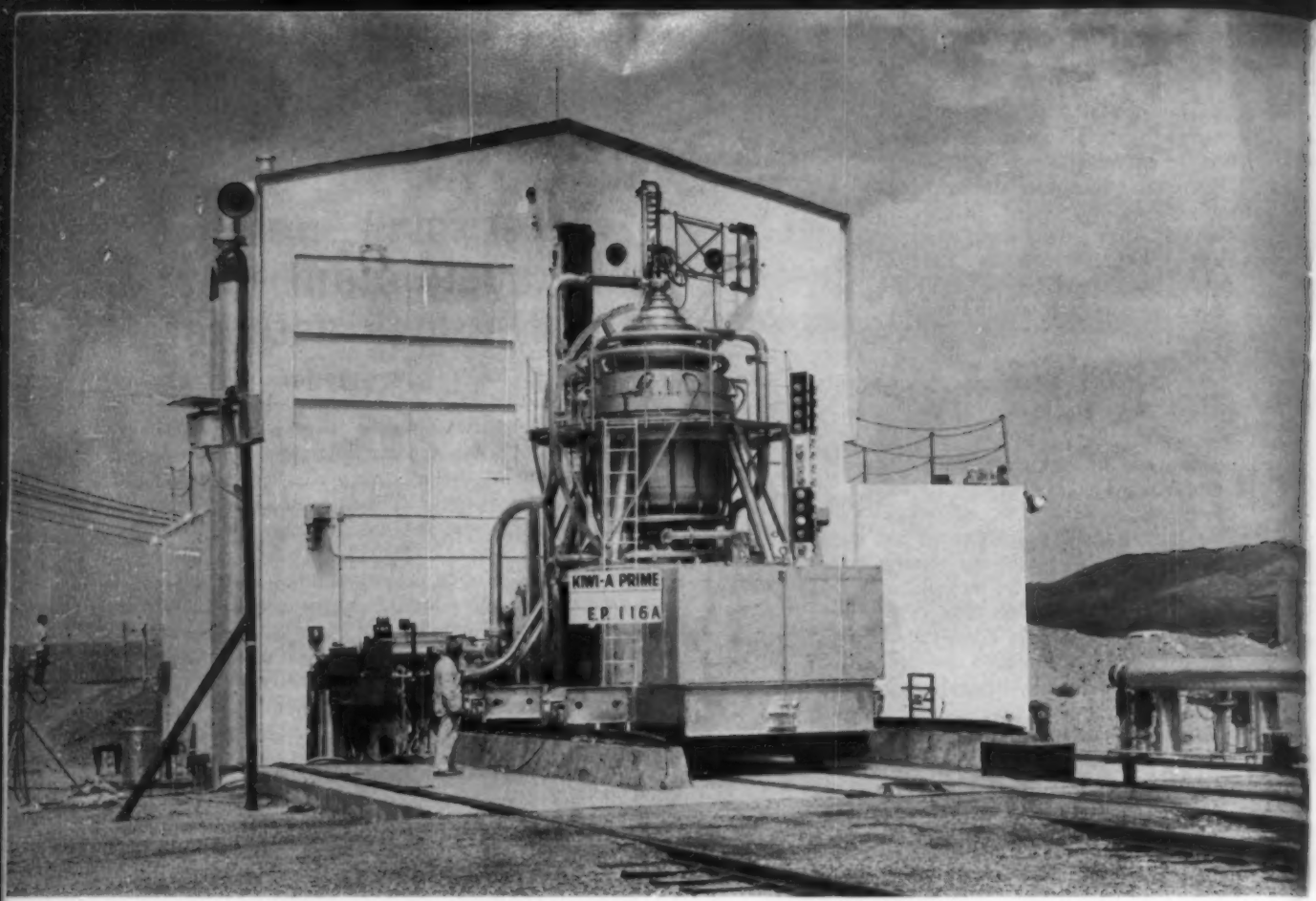


KIWI A-PRIME was given first full-power run on July 8. Some charge building lag caused 6-month delay.

Effects debated . . .

Construction Delays Hit AEC

Field officials charge rocket hardware testing has been set back; less serious view is taken in capital

by Frank G. McGuire

CONSTRUCTION PROBLEMS as serious as those which have plagued ICBM base activation have cropped up in the nation's nuclear rocket and weapons programs.

Considerable delay in the developmental testing of hardware in the nuclear rocket program has resulted, according to Atomic Energy Commission field officials.

Due to the nuclear test ban, the delays apparently have not seriously affected development of nuclear weapons—as yet. But the situation, while not new, is said to be getting worse.

Blame for the stoppages has been placed both on the construction firms building test facilities and on the unions involved. Teamsters, plumbers, electricians, and even security guards have been accused of walking off vital jobs "and sulking in the corner when things didn't go their way".

The situation has been labeled by one AEC spokesman as "the most disgusting exhibition yet of irresponsibility during a period of national crisis."

The blame for delays does not rest entirely with contractors and labor unions, however. Late delivery of vital equipment and AEC changes in specifications also are partly responsible.

William Ogle, alternate test division leader at Los Alamos, told the Joint Congressional Committee on Atomic Energy late last month:

"I have searched hard to find any one organization or set of people I can point to and say it is their fault. There is no such thing as far as I can find."

Regarding AEC's own role, he commented: "We have taken a little time to put in criteria, we have made changes

in the field, we have had normal types of delays in letting contracts and so on."

One source accused contractors in AEC construction programs of bidding low on a job in order to get the contract and then, with the job 90% finished, cutting manpower to the bone to save money. As a result, the remaining ten percent of the job slips past deadline due to contractor efforts to complete it with inadequate manpower.

There also have been slowdowns due to late delivery of special cryogenic materials, including piping and valves.

In several cases, after a job delay of months, the user of the facility was forces to apply the finishing touches, it was charged. Some lost time was made up by sacrificing less important quality requirements for such facilities, it was said.

AEC officials in Washington said this charge was exaggerated, however.

"In no case has the user of a facility had to apply finishing touches, except where changes to the original scope of the contract were made on an installation for the benefit and convenience of the government," a spokesman commented.

This comment from those concerned with management of the programs contrasted with reports received from operational personnel.

"As an example of what this sort of nonsense has cost us," a source close to AEC told M/R, "we could have tested Kiwi-B last fall, and now it will probably miss its scheduled firing next month. We may not get it tested until early in January, at this rate of progress."

This was questioned by those in charge of the program.

"In all probability," AEC commented officially, "modification of Test Cell A will be completed in time for the scheduled firing in mid-October. This has been the date for some months, although it was once scheduled for July. Construction delays are not entirely to blame for the slippage."

• **Low bid wins**—According to the rules under which construction contracts are let, the low bidder is selected even though his inadequacy for the job may be obvious, one source complained.

"And to make it worse," he added, "AEC refuses to put penalty clauses into these contracts to make certain the contractor performs. We can have a completely new reactor built and ready to test before they get a test cell constructed."

Another source in AEC's complex said the same problems have been experienced in other phases of nuclear activity. Sandia Corp., a nuclear-weapon research and development center which is now also doing some work on spacecraft, has had a major facility—its Sandia Engineering Reactor Facility (SERF)—delayed over a year due to contractor troubles. The building was scheduled for completion in 1960; it now "may be operating" in early 1962. When completed, it will be used to expose materials and components of nuclear weapons and other systems to radiation.

"Some of the delay is certainly due to the change orders we have made in the plans for our Nevada Test Site (NTS) rocket cells," a third source close to the programs conceded to M/R, "but this is greatly aggravated by the fact that the contractor often has no experience in building R&D facilities, and his people haven't the sense of importance needed to do it right. As a result, the entire job is sloppily handled."

He added that almost every succeeding major construction job at NTS has gone to a different contractor and architect-engineer because of poor performance by the firms which handled the previous job.

"If we had expected this much trouble in getting our new cells built on a staggered schedule," he asserted, "we would have told Los Alamos Scientific Laboratory to keep at least one test cell ready for continuous reactor runs. Instead we now have all our test cells down for construction or modification, because of slipping schedules, and can't run any tests until the contractors finish."

• **Casualty list** — Work on AEC's newest nuclear rocket Test Cell "C" is now at least six months behind original schedule, and may slip further. The testing delays, in terms of actual time, were listed as follows:

—Kiwi A—could have been tested one year earlier than it was.

—Kiwi A-Prime—delayed six months.

—Kiwi A3—not delayed.

—Kiwi B 1A—already four to five months behind schedule, and still not tested.

Kiwi B 1A has now been completely assembled and initially checked out, but much work remains to be done in mating, test cells compatibility, and other aspects of the program.

The sources interviewed by M/R were very critical of AEC's own enforcement of contract terms with companies doing test facility work.

The decision to throw a contractor off a job after lengthy delays is often postponed due to time that would be lost in phasing a new contractor into the half-finished job, it was reported. Result of this is to put the test considerably behind schedule and completely out of step with R&D work which has been continuing in the overall program.

Commenting officially on this charge, the AEC told M/R:

"In no case in the *Rover* program have there been enough grounds under government construction procedures to default a contract or 'throw a contractor off the job.' "

In general, the official AEC attitude is to regard the slippages in the nuclear rocket program as not very serious, particularly since there is as yet no requirement for the rocket in any weapon system.

This attitude has not been shared in the past by Congress, however. As recently as this May, a staff report submitted by the late Overton Brooks, chairman of the House Space Committee, recommended the *Rover* nuclear rocket program for a DX priority, the nation's highest. (M/R, May 29, p. 27).

That report called for selection of engine and vehicle contractors by the National Aeronautics and Space Administration "at the earliest practical date."

This has not been done, although NASA Administrator James E. Webb indicated in a National Press Club speech earlier this month that increased attention is being paid to the *Rover* program. He said a speed-up would include early selection of contractors.

The Brooks committee was concerned then with management of the program. It cited administrative delays in *Rover* in calling for more authority for the joint NASA-Atomic Energy Commission Space Nuclear Propulsion Office headed by Dr. Harold B. Finger.

This attitude is shared by some of the field officials closest to the program, who recommend a number of changes in administrative approach.

Among other things, it has been recommended that (1) the contracting system be revised so that a contractor would be under greater control regarding his ability and equipment to do a job on schedule, and (2) some sort of understanding be reached with labor unions involved, so that stoppages do not occur with the figurative frequency of "every ten minutes."

• **"Sabotage-by-neglect"** — One spokesman summed it up: "There is nothing to distinguish this program in importance from our ICBM base-activation program except that the missiles are a bit closer in urgency. We will all be staking our lives in a few years on nuclear rockets because of what they can do, and this is no time for sabotage-by-neglect to be allowed such a stranglehold on the program. The ICBM stoppage problem was solved partly by the spotlight of public awareness, but we don't have that advantage, and these selfish interests are holding us up . . . with dangerous after-effects quite likely."

Space potential . . .

New Code Names Clue To Future AF Plans

High-level AF group meanwhile draws up report on military space requirements

by James Baar

THE AIR FORCE is disclosing the main outlines of its R&D planning for the next 10 years in an official document that sharply revises the designation system for all "aerospace vehicles."

The document provides code designations for a broad variety of new missiles and spacecraft which would give the Air Force the capability of conducting major defensive and offensive operations in space and deploying a highly mobile third-generation ICBM on the ground. Such missions have yet to be approved by the Kennedy Administration.

Code designations are provided for missiles launched in space from "aerospace vehicles" and from "ground vehicles other than railroad cars"—presumably such as trucks and overland trains.

Designations also are provided for missiles and spacecraft with missions such as interception and defense, delivering cargo and in-space refueling. And the designations indicate a strategic mission for spacecraft.

Contents of the document—Technical Order 1-1-81—became known as a high-level Air Force Ad Hoc Committee sought to put together at the Pentagon a new report detailing Air Force plans and requirements in space.

The committee—headed by Maj. Gen. W. B. Keese, director of development planning—comprises about 20 high-ranking officers representing various parts of the Air Force. Part of its study involves a review of the considerable number of past studies and reports on the subject including the recent Gardner Report of the Air Force Systems Command.

The committee's report is expected to be completed in the near future and forwarded to Gen. Curtis E. LeMay, Air Force Chief of Staff.

• **Familiar theme**—To date no formal military requirements for defensive and offensive military spacecraft have been approved or established by the Department of Defense. However, many top Air Force officers have argued for some time that requirements for developing such systems do exist and programs to fulfill them should be started.

Despite DOD laundering, some clear indication of this can be seen in the speeches before the Air Force Association Convention this last week in Philadelphia.

Gen. Bernard Schriever, commander of the Air Force Systems Command, said:

"The ICBM, which is still in its infancy, is the first space weapon. It will inevitably be followed—more quickly than some people realize—by new space weapons that are more sophisticated and potentially more powerful. For this reason the aerospace force of tomorrow must be able to operate in space and to detect and counter any threat in that arena.

"Among the projected manned craft of the future we envision . . . the true aerospace craft that will be capable of flight both within the atmosphere and out in space."

Maj. Gen. Hewett T. Wheless, SAC director of plans, said:

"As air supremacy means control of the battleground today, space may eventually equate to control of the world. . . . It is not beyond the realm of possibility that this may require manned spacecraft which would orbit the earth in a continuous air alert."

• **Name changes**—Such statements take on considerably fuller meaning when placed alongside the technical order revising designations.

As for the employment of the designations themselves, they are expected to be used first with the Air Force's three ICBM systems—*Atlas, Titan* and *Minuteman*.

For example: *Atlases* in coffin launchers at Warren AFB, Wyo., and *Atlases* to be deployed in silo underground launchers at Plattsburgh, N.Y., are both designated SM-65.

The "S" stands for strategic. The "M" stands for missile. These remain unchanged (see charts). However, now two new letters—"C" for coffin and "H" for hardened silo—will be added. Thus, the *Atlases* at Warren would be designated CSM-65; the *Atlases* at Plattsburgh, HSM-65.

Similarly, there would be two designations for *Minuteman:* The HSM-80 stands for the silo-based missile; RSM-80 stands for the railroad-based missile.

The technical order also establishes a new series of numbers for missiles and spacecraft. New model numbers for missiles will run in a consecutive sequence beginning with "1." New model numbers for spacecraft space vehicles will run in a consecutive sequence beginning with "101."

Therefore, the designation for a spacecraft interceptor could be IJ-101. The designation for a truck-launched ICBM could be GSM-1.

None of the new designations are automatically retroactive. Changes will have to be initiated by the Air Force Systems Command, the Air Force Logistics Command or USAF Headquarters, depending on circumstances. Designations for new systems will be made through action by the Systems Command.

The first changes are expected to be the addition of launching environment codes to the designations for the ICBM systems. The first new designations using the new codes are expected to be given appropriately to the *Midas* and *Samos* satellite systems and the *Dyna-Soar* spacecraft. ⁂

Designations for Vehicle Types

Letter	Title	Description
G	Booster	A vehicle employed to launch and/or propel other aerospace vehicles
J	Spacecraft	A vehicle designed primarily to operate in space
M	Missile	A heavier-than-air vehicle with a capability of travelling within or outside the earth's atmosphere whose trajectory or flight path may be controlled by installed or remote control mechanisms and which is not designed for human accupancy
P	Probe	An instrumented vehicle used to penetrate the aerospace environment and report back information
R	Rocket	A non-guided missile
S	Satellite	An aerospace vehicle designed to orbit

Designations for Missile Launching Environments

Letter	Title	Description
A	Aircraft	Aircraft-launched
C	Coffin	Horizontally stored in protective enclosure
G	Ground Vehicle	Launched from a ground vehicle other than a railroad car
H	Silo	Vertically stored and protected below ground level
M	Multiple Launch	Capable of being launched from more than one environment. Applicable only when type, model and series are identical
P	Soft Pad	Stored on unprotected pad and launched above ground
R	Railroad Car	Launched from railroad car
S	Space	Launched from aerospace vehicle in space

Designations for Missions of Missiles and Spacecraft

Letter	Title	Description
B	Communication	Designed to receive, transmit, relay or reflect electromagnetic impulses
C	Cargo and Logistic Support	Designed to transport materiel and personnel
E	Early Warning	Designed to provide early warning of attack
I	Intercept-Defense	Designed to be employed in Air Force defense missions
K	Tanker	Designed to provide in-flight refueling of other vehicles
N	Test	Designed primarily for the purpose of testing vehicle design of a new or radical nature
P	Propulsion	Designed to launch space vehicles and/or place them in orbit
Q	Target	A guided missile employed in Air Force target mssions
R	Reconnaissance	Designed for use in Air Force reconnaissance missions
S	Strategic	Employed in Air Force strategic missions
W	Weather	Designed for weather observation and reporting
X	Research	Designed to explore and study the elements in the outer atmosphere and space

At AFA Meeting:

U.S. Survival Linked To Weapons in Space

PHILADELPHIA—The Air Force firmly linked advancement in technology, space weapons and national survival as a major theme at the annual Air Force Association Convention.

Maj. Gen. David A. Burchinal, director of plans in the office of the Air Force Deputy Chief of Staff for Plans and Programs, bluntly told hundreds of industry representatives and military men attending the meeting:

"If we lose (our) base of technological superiority we will be in serious difficulty. This principle is particularly applicable to our efforts in space."

The general delivered his key address only some three days after Defense Secretary Robert S. McNamara told a press conference that he was still studying whether to spend an extra $85.8 million added by Congress to the defense budget for *Dyna-Soar*. He gave no indication when the study would be completed.

General Burchinal said:

"The last decade has raised some warning flags. In the face of major effort by the Communists to overcome our superiority we did not keep pushing our scientific effort—our research and development effort—hard enough toward new and improved weapons, new and improved delivery systems and new techniques for defense.

"We must now face that fact and recognize that it will require a major effort on our part to maintain the margin of technological superiority from which discriminate military superiority may be achieved and maintained."

Burchinal warned that in attempting to do this "our resources and scientific manpower, laboratories and other facilities are not unlimited." He said "they must be carefully husbanded, their efforts integrated and closely managed with purpose and clear objective to make maximum progress in minimum time."

• **Implicit commentary**—And then he added pointedly:

"Maintaining our position of preeminence is not merely a matter of national prestige. In the decade ahead, it may well mean survival."

Other speakers picked up bits and pieces of the theme, sketching in the details as to what kind of space weapons are needed. No one pointed fingers at the present national man-to-the-moon program mostly in the hands of NASA. But the message was there.

To hurry Apollo . . .

Saturn Development May Be Speeded

SPACE AGENCY OFFICIALS—pushing hard to meet a mid-October target date for the first launch of the *Saturn* booster—are considering accelerating the *Saturn* development schedule.

The demands of the *Apollo* program are the prime reason for the expected step-up. NASA would like to cut some time off the 1964 date for operational *Saturns* in order to speed *Apollo* spacecraft development. It is expected that funds to accomplish the speed-up will be requested in the Fiscal 1963 budget.

Officials report that preliminary checkouts for the first launch of the *Saturn* from Cape Canaveral "look good." Earliest possible date for the shot is the week of October 9.

If successful, the 1.5-million-lb.-thrust first stage will lift from its pad, burn for two minutes, shoot to a top altitude of 100 miles, and then sink ingloriously into the Atlantic some 200 miles downrange.

Besides proving that the U.S. answer to Russia's rockets can fly, other primary goals of the first launch include:

—The first test of the launching equipment, and the compatibility of the equipment with the space vehicle.

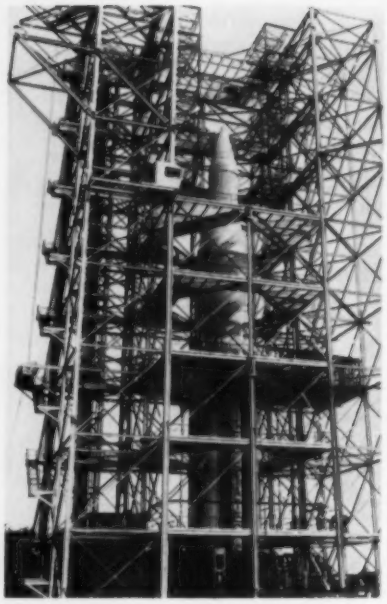
—Ascertaining the effect of the launch on the launch pad. Space agency officials know that the pad will be damaged during each launch, but how much and in what way must still be determined.

—Obtaining air frame information, including how the liquid hydrogen-oxygen propellant will feed during the launch and how maximum dynamic load will affect it.

• **Evolution**—The first *Saturn*—currently on its pad at Cape Canaveral—resembles its later prototypes only in outward appearance. Only the first stage—powered by eight H-1 engines developing 165,000 lbs. thrust each—will be live. The second and third stages will be dummies.

A similar vehicle will be used in the second *Saturn* launch scheduled early next year. While the shot will be similar, *SA-2* will have a new guidance system which will be a refinement of the *Jupiter* missile guidance system on *SA-1*.

Following in quick succession, *SA-3* is currently scheduled to go up in the third quarter next year. *SA-4*—for the first time—will include a live second stage which will have six LR-110 engines developing 15,000-lbs.-thrust each.



SATURN C-1 assembled in its huge gantry. Height with dummy upper stages is 163 ft.

None of the first ten *Saturn* shots will have a live *Centaur* third stage.

Beginning with *SA-7*, boilerplate *Apollo* spacecraft will be test-flown. These shots will end with *SA-10*—now scheduled to wind up the development series sometime in 1964.

A successful *SA-1* shot would greatly enhance the chances of the development speed-up. Besides convincing Congress that funds for that purpose would be well spent, it would also enable the space agency to move ahead more confidently with the *Saturn* program.

• **Delayed conference**—Meanwhile, it was also learned that NASA expects to hold a bidders conference on the S1^b stage of the *Saturn* sometime next month.

It was originally hoped that the conference could be held about two weeks following the bidders conference on industrial development of the *Saturn C-1* first stage, but indecision as to whether the S1^b stage will have two or four F-1 engines has held up the proceedings.

Inability to decide on the final configuration of the *C-3*—or the *C-4* as it will probably be called if it does have four F-1 engines—stems from the lack of a decision as to the feasibility of the "rendezvous" concept of flight to the moon.

While this was earlier discounted by NASA, its adherents have recently grown appreciably more numerous. Officials report that while "direct descent" is still the most favored approach to a manned lunar landing, the chances of some form of rendezvous being used have grown stronger.

Officially, the space agency still holds that the S1^b stage will have two F-1 engines. If the rendezvous concept is given final approval by a joint NASA-DOD committee, however, it is likely that a four-F-1-engine version will be built.

• **S-1 bidders** — The space agency last week invited 37 firms to attend a bidders conference on the S-1 stage of the *Saturn C-1*, which will have eight H-1 engines.

The firms included Aerojet-General, American Machine and Foundry, Avco Corp., Beech Aircraft, Bell Aerosystems, Bendix, Boeing, Brown Engineering, Chance Vought, Chrysler, Douglas, Firestone Tire & Rubber, Ford Motor, General Dynamics/Astronautics, General Electric, General Motors, General Precision, Goodyear, Grumman, Hayes Corp., Hughes Aircraft Co., Kaiser Industries, Lockheed, Martin, McDonnell, Minneapolis-Honeywell, North American Aviation, Northrop, Raytheon, Republic Aviation, Ryan Aeronautical, Sperry Rand, Sylvania, Temco Electronics and Missiles, United Aircraft, Western Electric and Westinghouse.

The conference will be held at 9:30 a.m. at New Orleans Municipal Auditorium. The contractor selected will operate in a government-owned facility 15 miles east of New Orleans, formerly known as the Michoud Ordnance plant. Bidders will have until October 16 to enter proposals at Marshall Space Flight Center. A contractor will be selected for negotiation probably in November.

It is considered that the list of firms invited to the bidders conference on the S1^b first stage will closely approximate the roll call at the New Orleans conference. ⌗

Ford Motor Buying Philco; Douglas to Close Segundo

TWO MAJOR DEVELOPMENTS marked the changing shape of the industry this week:

—Ford Motor Co. was moving to beef up its competitive position in the missile/space industry with the purchase of Philco Corp.

—Douglas Aircraft Co. announced its decision to close its El Segundo, Calif., plant due to the fading market for manned aircraft.

Pending stockholder approval, Ford will purchase Philco under terms of an agreement signed by both Boards of Directors.

In making the announcement, Ford Board Chairman Henry Ford II said his company's "purpose in purchasing Philco Corp. is to broaden its operations, to provide entry into new fields and to make possible a fuller participation by our company in the national defense and space effort."

In Denver, Ford president John Dykstra told the National Defense Transportation Association that Ford is "moving into the defense and space business with both feet. We are determined to be in the vanguard of our country's effort to regain Space Age leadership." He said that as part of this Ford is making a determined effort in bidding on the first-stage booster of *Saturn*.

Meanwhile, Douglas plans to close its El Segundo plant because of what the company's Jackson R. McGowen calls "the inevitable result of a downward trend in aircraft production that has affected the entire aerospace industry."

McGowen, vice president-general manager of the Aircraft Division, said work at El Segundo, which produces the A4D attack aircraft, would be transferred to the Long Beach and Torrance, Calif., plants. The move will require approval by the Navy, which owns most of the facility. McGowen issued the statement "to set the record straight" after a group of International Association of Machinists union members threatened legal action to prevent closing of the plant.

A spokesman for the IAM group, acting without union backing, said the company, under its IAM contract, has the right to transfer its operations to the other plants but "has to offer its employees the right to go along." The official IAM position was expected late in the week.

In other industry developments:

NATIONAL COMPUTER ANALYSTS OF NEW YORK, INC. has been formed to offer management consulting services to manufacturers and users of electronic computers.

Services will include initial feasibility study, evaluation of manufacturers' proposals, selection and training of client personnel, programing of the specific application, and implementation of the total system.

ELECTROMAGNETIC TECHNOLOGY CORP. has been formed in Palo Alto, Calif., as a research, development and engineering organization.

It will operate in the field of electromagnetic technology, with initial emphasis on R&D programs for industrial and governmental clients. EMTECH will also initiate company-sponsored projects expected to lead to development of proprietary electromagnetic devices and systems.

Douglas's McGowen

". . . a downward trend in aircraft . . ."

COLLINS RADIO CO. will complete work next month on two major Dallas area facilities. A manufacturing building will house special-product manufacturing and assembly functions, and a 24,000-sq.-ft. structure will house antenna research facilities.

ASCON MANAGEMENT CORP., a marketing services organization, has established an Export Management Div. to assist California manufacturers of technical products in research, planning, administration, promotion and selling activities abroad.

CORNING GLASS WORKS has established a Radome Department, operating as part of the company's Technical Products Div. The operation was previously part of Corning's New Products Div.

TRANSITRON ELECTRONIC CORP. announced a major change in its organization structure with the appointment of four Operations Managers. They will be responsible for operations of transistor, diode, rectifier and special product lines.

LASER INC. has been formed as a subsidiary of the American Optical Co. to do fundamental research in the laser field. It will be headed by E. Weldon Schumacher, president of American Optical.

AO says it is investigating, under an AF Aeronautical Systems Div. contract, a sun-powered laser that would use direct sunlight as a power source.

DATA SENSORS, INC., Gardena, Calif., has been formed to engage in research, development, engineering design, and manufacture of electrical, electronic and electro-mechanical instruments used in data acquisition, conditioning and interpretation for military, space and industrial programs.

RADIO CORP. OF AMERICA has changed the name of its West Coast Missile and Surface Radar Div. to the Data Systems Div.

The division has been active in Automatic Program and Checkout Equipment (APCHE), designed and manufactured for the *Atlas D, E* and *F* series, as well as Digital Information Processor (DIP computer).

AMP, INC., Harrisburg, Pa., consolidated its multiple-conductor electrical and electronic connector operations into a new Multicon Division.

The division will operate exclusively in the engineering and manufacture of multiple-conductor connectors. Products will include pin and socket type connectors, printed circuit board connectors, multiple coaxial connectors and related items.

INSO ELECTRONIC PRODUCTS, INC., Nutley, N.J., has announced several organizational changes folowing its association with KPT Mfg. Co. and Shepherd Industres, Inc.

W. P. Turner has been appointed executive vice president, H. H. Heyden, vice president for sales, and Dr. R. E. Warner, secretary.

The three New Jersey firms have pooled management, manufacturing and sales capabilities.

EW MARKET

Funding to More than Double by '66

Present bulk of spending is for aircraft EW equipment, but missile/space will go far into lead

by Charles D. LaFond

THE MARKET for electronic warfare (EW) equipment in the missile/space field will more than double in the next five years—from well over $50 million in Fiscal '62 to an amount exceeding $130 million in Fiscal '66.

That is the EW market picture emerging from the best available industry estimates.

Today, the largest share of the EW expenditure goes for aircraft equipment. This will be altered radically in the next five years. By Fiscal '66, by far the heaviest volume of spending will be on equipment for missiles and spacecraft.

Current spending of more than $50 million for EW in the missile/space field is part of an overall annual expenditure of some $500 million to $600 million on electronic warfare. That figure includes R&D and hardware for air and ground systems, all military services, the Central Intelligence Agency and the State Department. The State Department alone is believed to account for over $100 million of the market, primarily in custom-built special receivers, analyzers and anti-intrusion devices.

Today's expenditure of some $50 million on missile/space equipment and related ground hardware contrasts with aircraft EW spending in the neighborhood of $140 million. But the Fiscal '66 volume of some $130 million in the missile/space field will overshadow spending of less than $90 million on aircraft equipment.

As used in this survey, the term Electronic Warfare includes all systems directly associated with the art and technologies of electronic reconnaissance, surveillance, countermeasures, counter-countermeasures (ECCM), and simulators necessary to teach the technologies.

ECM includes all systems, active or passive, used to electronically jam, deceive, or confuse enemy radar, communications and electronically controlled devices.

Major Electronic Warfare Contractors With Their Estimated Share of the FY '60 Market

Contractor	Share of Market
Sylvania	18.7%
General Electric	16.5
Airborne Instruments Laboratories	14.0
Subtotal 49.2%	
Hoffman	5.9%
Sperry-Rand	5.6
Emertron	4.0
Hallicrafters	3.9
Loral	2.6
Westinghouse	2.6
Webcor	2.3
IT&T	2.2
Motorola	1.4
Emerson	1.2
RCA	1.1
Stanford University	1.0
University of Michigan	1.0
Raytheon	0.7
All others	15.3
Total	100.0%

The Electronic Warfare Market

(Direct Missile/Space/Aircraft Applications Only)

	1961	1962	1963	1964	1965	1966	1970
By Environment				($ Millions)			
Aircraft	150	131	133	126	118	100	80
Missile	10	27	34	41	57	60	60
Space	12	21	23	37	45	60	60
Ground/Ship	27	30	30	36	40	40	40
TOTAL	199	209	220	240	260	260	240
By End-Users							
Air Force	145	137	141	156	176	175	155
Army	8	21	24	29	29	30	30
Navy	46	50	53	51	51	50	50
NASA	—	1	2	4	4	5	5
TOTAL	199	209	220	240	260	260	240
By Type of Equipment							
Active ECM (Jammers)	100	100	80	80	70	70	50
Decoys & Repeaters	39	39	60	60	70	70	55
Ferrett Intelligence and other Passive	60	70	80	100	120	120	135
TOTAL	199	209	220	240	260	260	240

• **Market environment**—The EW market during the past 15 years has shown an almost steady and continuous growth. This trend is expected to continue its upward spiral after a temporary leveling-off during the 1961-62 period.

In the past, the market was characterized by two facts:

—A majority of major EW systems and equipment was built for installation in aircraft.

—Better than 80% of the total EW market was for active electronic countermeasures (ECM) systems such as jammers and decoys.

Technological breakthroughs in modern weaponry, combined with the steady decrease in manned aircraft, have reoriented military EW requirements. Jammers alone no longer present a reasonably effective aircraft defense method and, while still reqiured, are used in steadily decreasing numbers.

Concurrent with this development, Soviet advances in the field of electronic technology have made it imperative to multiply and diversify the means of an electronic intelligence at the disposal of the U.S. and NATO military establishments.

Passive electronic intelligence and reconnaissance techniques are suitable for all environments, but prove especially effective for long-range airborne exploration, and even more so for utilization within space vehicles. Advanced aircraft and space vehicles will employ complete ferret systems to provide intelligence on enemy electronic warfare equipment—including types of gear, bandwidths, location and power.

• **Changing trends**—Also, it should be noted that the EW market in the past was almost exclusively available in form of prime contracts. This situation is changing, although the bulk of the business will continue to take the form of prime contracts during the next several years. Significant changes in this structure are not expected prior to 1964.

The trend is now clearly running toward increased passive requirements, as the emphasis in future production changes from manned to unmanned craft. Following the expected peak in the 1963-1964 era, the trend should again begin to reverse itself with a change to more active systems for use in missile systems.

Advances made just this year indicate a solution shortly to the communication problems of a re-entering warhead.

Aircraft will take a diminishing but still major portion of the EW production market through 1966. The biggest user today is the Strategic Air Command. Although electronic warfare for missiles is expanding, this market alone is not expected to overtake the aircraft portion. It is in combination with the space market, largely R&D through 1966, that it surpasses aircraft.

As with most suppliers, the majority of electronic warfare competitors generally become identified with one branch of the military, and known for their competence in development and producing particular types of equipments or systems.

• **Detailed picture**—A major EW supplier has made a detailed analysis of prime electronic warfare programs which were awarded and reported over the last few years. These awards were extended over the contract period and an estimate was made by the company of all expenditures during the 1960 fiscal year, by contractor and by customer.

The awards were also identified as to type (active countermeasures, reconnaissance, or counter-countermeasures) and ultimate application.

This analysis covered a total of 75 government contractors which had expenditures on electronic warfare programs. The summation of these expenditures accounted for 73.5% of the total aircraft/missile/space electronic warfare market for FY 1960.

Results of this analysis shows that 15 industry contractors and two universities had estimated contracts of $1 million or more on reported prime programs.

The expenditures to these contractors then were adjusted for such factors as classified programs, small contract awards and field service engineering in order to produce a more accurate division of the market. These contractors are aligned in accordance with their share of the market in the accompanying table (p. 18). The top three, Sylvania, General Electric and Airborne Instruments Laboratories, account for almost 50% of the total market.

Others having long experience in the field but not listed in the table include: Collins Radio, Hazeltine, Electronic Specialty Co., HRB-Singer, Sanders, Martin Co., Maxson, and Reflectone.

The strength of major electronic warfare competitors must be judged by considering many ingredients—experience, technical competence, program costs, delivery record, financial and physical resources, and desire of management.

Today's major electronic warfare competitors, classified according to their recognized strength in specific equipment areas, include: (active) Emerson, Emertron, General Electric, Hallicrafters, IT&T, Maxson, Motorola, Raytheon, Sanders, Sperry, Sylvania, Webcor, Westinghouse; (passive) AIL, Electronic Specialty Co., Hoffman, IT&T, Loral, RCA, Westinghouse.

NEW APPROACH to global reconnaissance will begin with Samos. Built by Lockheed, the satellite will be capable of employing many types of electronic and photographic detection and recording devices. The system is scheduled to be operational by late 1962 or early 1963.

In the active countermeasures area, Hallicrafters and Sanders appear to be the competitors to watch. Hallicrafters is rapidly gaining a significant share of the Air Force's barrage-jamming business, while Sanders has some of the most important Navy deception-jamming programs. In the reconnaissance field, Loral is making new inroads on ferret receivers for the Air Force.

• **The future**—Conservative estimates of the missile/space EW market show a leveling-off from 1966 to 1970.

Not-so-conservative estimates of the whole EW field put the total 1970 market between $800 million and $900 million. Those going "way out" on their estimates concur in this reasoning. They believe the great influence will be an acceleration in the deception (decoy) field.

They say the need will exist, the technology will permit it, but the question will be how much the military will emphasize development and later production.

Other disagree. They believe the "Berlin buildup," extension of SAC programs, growing emphasis on battlefield surveillance and radio frequency intelligence, plus continued high level of ship building and modification (FRAM) activity will cause steady increases. However, they see a leveling off after the mid '60's after the large production buys are completed. ⊠

EW PROBLEMS

Research Effort Found Sadly Lacking

Experts feel far greater emphasis must be given to development of new methods and components if needed 'upgrading' is to be achieved; weapon system tie-in blamed

MORE EMPHASIS on EW technique and component development, higher power for active ECM, improved methods for analysis and discrimination of mixed radio-frequency transmissions —these are the most serious needs today in the electronic warfare field.

Most of the leaders in EW feel that our R&D effort is woefully inadequate. They see relatively little emphasis on the development of unique techniques and components—this despite the requirement for speed in "upgrading" selected electronic warfare components and techniques in order to successfully "match" the weapons they attack.

Unless this development takes place, EW is not likely to be of much use.

The consensus is that the lack of emphasis stems primarily from the fact that most of the dollars for technique and component development are tied to particular weapon systems—and are justified by them. Only those items that can satisfy the time scale and specific needs of the weapon system can be pursued. Because of this, significant gaps now exist in our background of information on components and techniques.

As a result we do not now have a good capability of configuring new systems quickly for effective use against specific sets of new "targets" as they arise. Our ability to wage effective electronic warfare is seriously reduced.

What is required, they assert, is that many more dollars be made available to support critical component and technique areas on a continuing basis, independent of any particular weapon system or other specific application of the EW art.

• **Discrimination**—Probably the biggest problem in passive ECM today is that of sorting. With the enormous increase in the use of radar for aircraft traffic control, aircraft landing aids, storm detection, marine navigation and even automobile speed measurement, determining just what is a threat and what isn't has greatly complicated the electronic reconnaissance problem.

Not only must all of these data be recorded, but they must be analyzed to determine what are the threats, whether the old ones are still in use and whether there are any new needles in the proverbial haystack. For this, of course, a great deal of effort is being expended to utilize computers to assimilate and process these data.

• **Power**—For active countermeasures, more power is required. This requires more and more primary power from missile-carrying aircraft and greater and greater heat dissipating capabilities. To lick this problem, the tube and equipment manufacturers are making every effort to make their products more efficient.

Using the greater power output of improved jammers calls for better aircraft antennas and transmission lines. This major problem will be solved only with time and money.

With the advent of ballistic missile defense, offensive missiles will require ECM both active and passive. Needless to say, this is receiving much thought.

• **Time of essence**—Another constant problem in electronic warfare, possibly greater in this field than in any other, is time. There is an electronic warfare race—although it doesn't get the publicity of the missile race and the space race. For every new threat, a countermeasure must be found.

Many feel a major breakthrough was made when the Department of Defense in 1953 solved the time problem by the implementation of QRC (Quick Reaction Capability) for EW. Under this concept, the study, R&D, development, testing and supply of new hardware is compressed from seven years to less than one year, often weeks.

QRC, coupled with a broad, well-funded R&D program, could effectively minimize the time problem.

In passive EW, these are compelling requirements:

—Antennas that can provide (1) the freqency ranges required by improved aircraft receivers, and (2) the identification and location of signals of interest. Also, new antennas for satellite use that can meet the severe environmental requirements and yet provide the required direction-finding accuracies.

—Automatic detection, surveillance and analysis systems.

—Rapid-scan, digitally programed receivers.

And for active EW, here are some of the more stubborn problems:

—Techniques should be developed for using duct-mode propagation for really effective long-range communications jamming.

—Practical solutions to the plasma-sheath radiation barrier about nose cones must be found as soon as possible to permit effective use of active missileborne ECM.

—Techniques must be developed to permit control of aircraft and missile radar cross-section. This may include development of new or better dielectric materials for nose cones.

—Higher radar sophistication is required, using pulse compression, frequency agility techniques, and correlation devices.

—There is a need for better evaluation of countermeasures susceptibility of new radar systems.

—Training devices are needed to provide more realistic simulation of actual signal environment. These should supply more detail of antenna radiation characteristics and a variety of signal simulation of a countermeasure environment.

Finally, these are a few of the more general problems experienced by contractors in EW development programs:

—No one has ever established a complete and thorough operational program to confirm systems effectiveness.

—Too seldom are there accurate specification requirements mutually agreed to and understood by both contractor and customer.

—Too often is there completion of a development program, followed by the discovery that the final hardware is obsolete.

—Using the Quick Reaction Contract approach, it is often difficult to hold development groups intact while the hardware is being evaluated. This generates problems in subsequent production or improvement. ⌗

TEST DIRECTOR'S console used to follow launch and orbital phases of Samos. Selected data of many kinds can be displayed on television screens or projected on wall-size screens.

EW FUTURE

More Active ECM for Big Missiles

Another major development may be solution of plasma sheath problem; Samos to open doors in surveillance

THE NEED for electronic warfare systems in the Space Age is assured; only their form and emphasis are in question.

The research effort today represents about 20% of the total EW dollar. Industry itself has almost an equal investment in current R&D. The total R&D effort appears to be divided almost equally between active and passive systems.

Principal change in the field over the next few years will be increased use of active electronic countermeasures (ECM) in ICBM and IRBM warheads. The plasma sheath problem may be on the way to final solution by scientists at the Hallicrafters' Research and Development Div. in Chicago.

In addition, the solution apparently offers a method to use the ion sheath to alter radar cross-section.

• **The vehicles**—The next military space vehicle to be introduced which will call for broad EW use probably will be the reconnaissance and surveillance satellite developed essentially around the hardware for the ballistic missile. These vehicles, starting with *Samos*, are expected to become operational in late 1962.

Altitude capability for such systems will be somewhere between 200 and 1000 nautical miles, velocity will be about 4 nautical miles/second, and payload will be from 0.5-1 ton.

R&S satellites will certainly have significant parts in the electronic environment of the future. Many feel they will be flying in considerable strength by 1965.

After 1965, the manned *Dyna-Soar I* and *II* boost-glide vehicles will come to the front. If successful, they should lead to the development of still more advanced types: a high-endurance manned satellite or an orbital bomber. Orbital characteristics of the orbital bomber probably will be similar to those of the R&S satellite. The manned orbital vehicle will probably run to a considerably higher weight range.

• **The big change**—Beyond this point predictions cannot be made confidently; too much depends on technical breakthroughs yet to be accomplished. However, these vehicles offer staggering potentialities and promise to revolutionize military thinking.

Samos alone opens the door for rapid continuous surveillance of enemy territory to secure up-to-the-minute intelligence data previously unobtainable. Here's how Forrest Cooper, Jr., manager of ECM engineering in General Electric's Light Military Electronics Dept., sums up the new situation in space:

"The ability of satellites to provide dependable worldwide communications will give attacking or counterattacking forces the benefit of extremely high vehicular performance. It is against such a background of vastly improved weapon capabilities that we must try to answer the question: What will be the role of electronic countermeasures?"

Effective defenses against space vehicles simply do not exist today—unless we accept counter-deterrence or massive retaliation as a reliable defense. The extent to which defense capabilities must be developed is a factor of the performance to be expected from the vehicles themselves. If altitude and speed alone are considered, Cooper asserts, this would mean about a tenfold increase over the figure for manned bombardment weapons—or air-breathing vehicles in general.

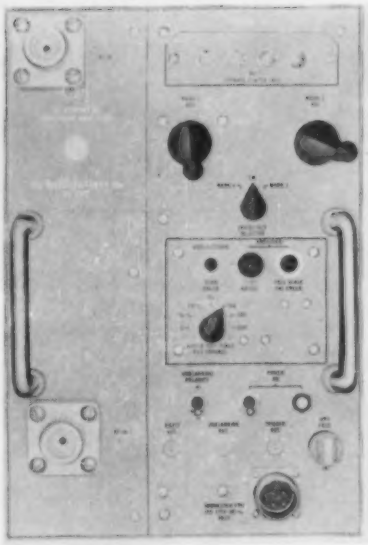
There is a good argument that these

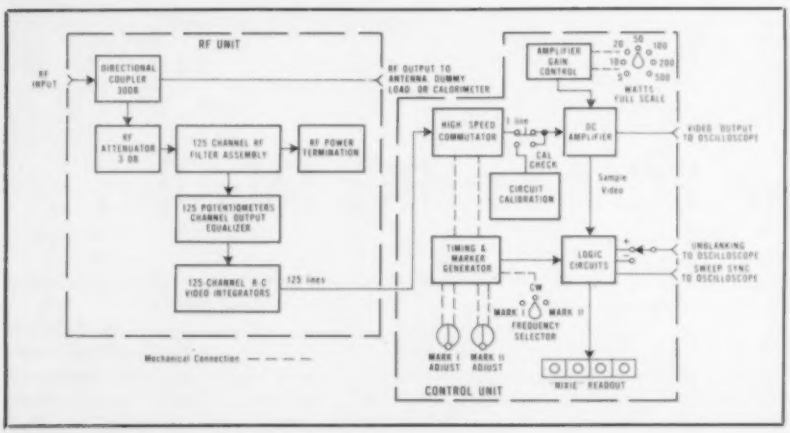
New ECM Analyzer

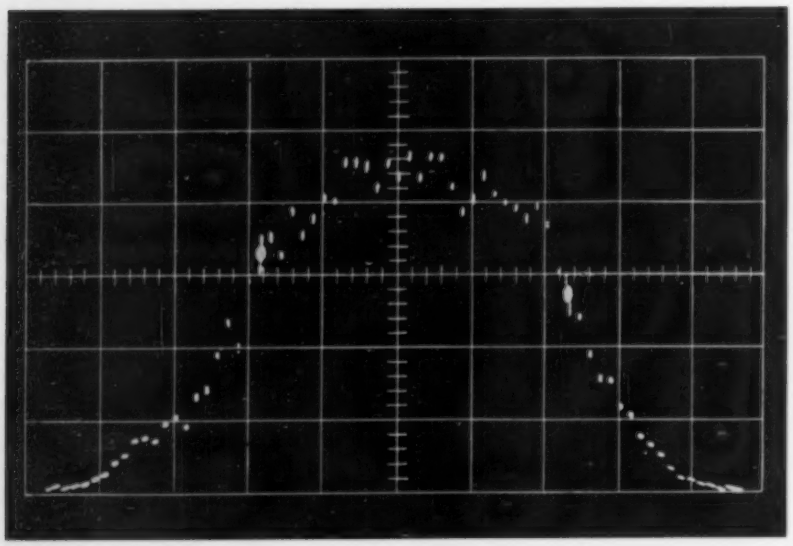
RIGHT: *First of its kind, Hallicrafters Incremental Power Spectrum Analyzer automatically plots and continuously displays power-vs.-frequency characteristics of r-f generating devices in the microwave spectrum. System is not only unique advance for determining characteristics of ECM-type transmission, but will find broad use in electronics laboratories.*

BELOW: *Block diagram of the analyzer.*

BOTTOM: *Typical oscilloscope display produced by the Incremental Power Spectrum Analyzer monitoring the output of a voltage-tunable magnetron modulated by f-m noise. Dots represent average power measurements in watts for 10-mc/s increments across the signal spectrum. The two bright dots are adjustable and calibrated frequency markers.*







tenfold increases in performance can be achieved.

That consensus, Cooper says, is based on the fact that early warning and surveillance radars in a defense network must have maximum detection ranges an order of magnitude greater than comparable radars operating in a defense network against manned aircraft. The same line of reasoning holds true for local defense tracking systems, in addition to the increased accuracy required to provide a reasonable probability of intercept for a defensive missile.

Overall system gain of a radar system is proportionate to the fourth power of range capability of that system; it follows that the requirement of a tenfold increase in range capability involves the further requirement of a ten-thousandfold increase in system gain.

So far, the required increase in gain has been accomplished by increasing both antenna areas and radar average powers one hundredfold, thus providing a net system gain of ten thousandfold—and also, unhappily, providing physically enormous radar systems. Components for systems such as those used in BMEWS have already been proved feasible. It also appears feasible to design and build the electromagnetic data-gathering systems needed for defense against space vehicles.

Further, there are properties of space vehicles that will help a defense network conduct a successful interception. Prediction of missile flight paths is practical. Similarly, the orbit of a reconnaissance satellite or an orbital bomber can be readily established.

One thing is certain. Whether the satellite system or the boost-glider is employed in the future, the result of their operating requirements—maximum altitude with little maneuverability or much less altitude with a little more maneuverability—offers an advantage for the opposing defense system.

Therefore, it can be seen that, based on the properties of space vehicles and in spite of their very high performance characteristics, these vehicles will not provide assurance of defense penetration with impunity. There is an objective need for effective countermeasures to baffle defensive radars and make the penetration easier.

• **Alternatives**—There are several approaches, in both the active and passive categories.

Because of their simplicity and particular suitability, various types of fragments can be used for deception or radar confusion. Space vehicles whose flight trajectory places them in a nearly complete vacuum, could be surrounded with clouds of very lightweight radar-reflective matter ejected from the vehi-

(Continued on page 31)

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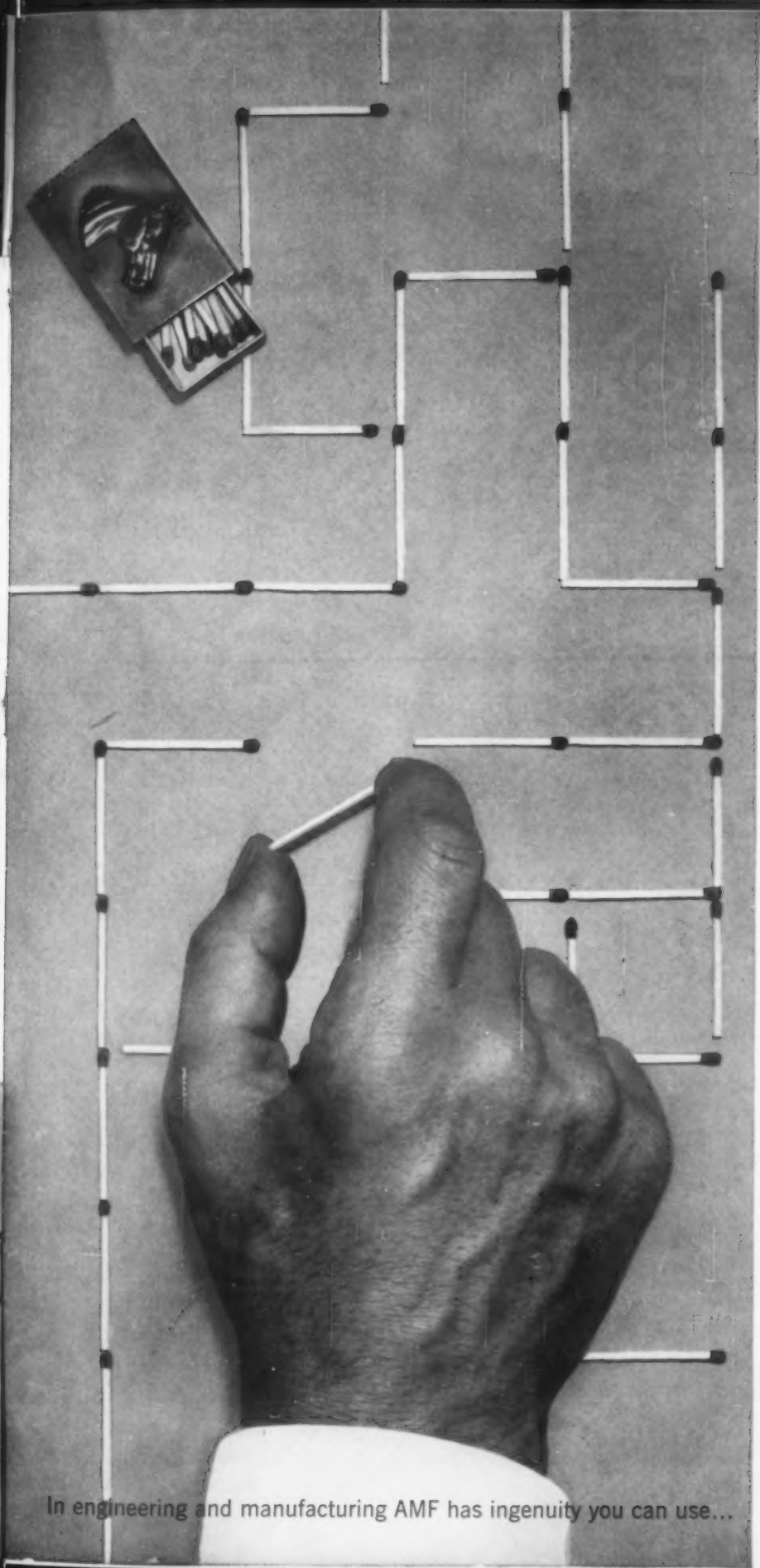

In engineering and manufacturing AMF has ingenuity you can use...

He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

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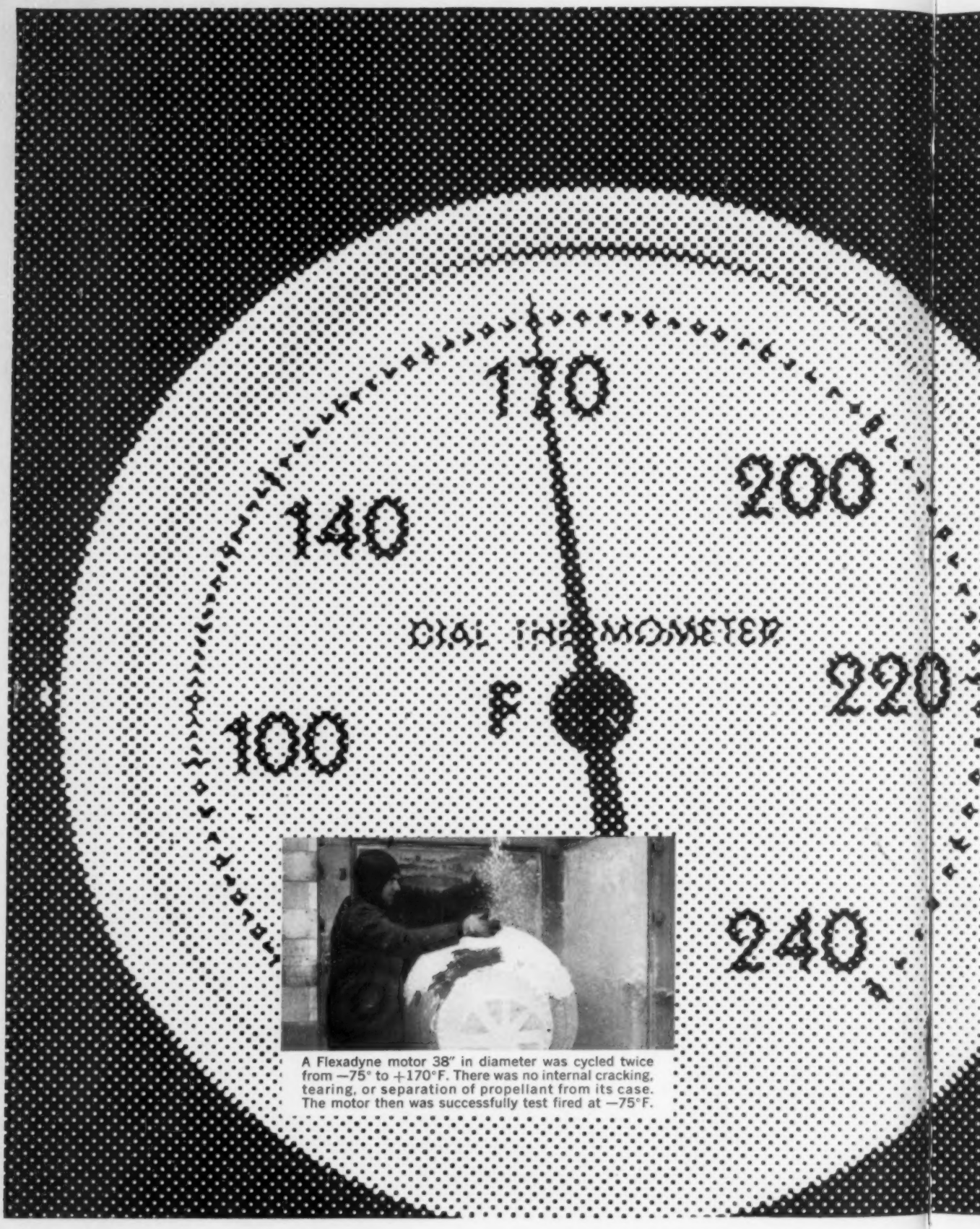
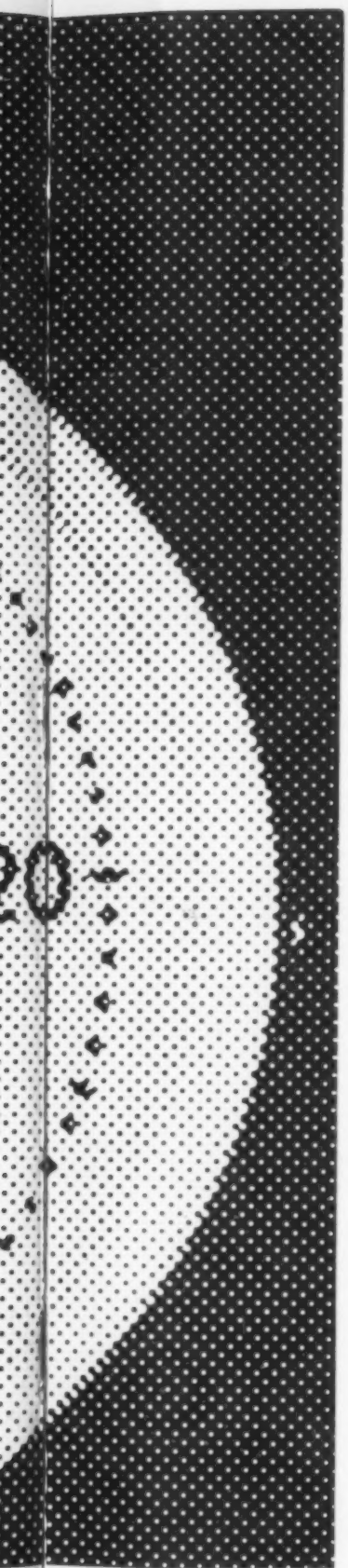


A Flexadyne motor 38" in diameter was cycled twice from −75° to +170°F. There was no internal cracking, tearing, or separation of propellant from its case. The motor then was successfully test fired at −75°F.



Another Rocketdyne Breakthrough:

Flexadyne— first solid propellants with proven temperature capability

From Rocketdyne, the pioneer in rocket propulsion, comes a family of advanced solid propellants. They are the first case-bonded solid propellants to offer superior performance proven throughout the broad temperature range of −75° to +170°F. They are called Flexadyne.

For multi-million-pound thrust solid propellant boosters, the use of Flexadyne means longer storage life, added performance. Air-launched missiles now can realize full mission flexibility without propellant cracking or bond failure due to extreme environmental temperature changes. No cumbersome "heater blankets" or other temperature conditioning equipment will be required for surface-launched missiles whether deployed in the frigid Arctic or blistering desert. Flexadyne's high resiliency promises maximum compatibility with extremely lightweight plastic rocket cases and resulting improvements in range and payload for any solid propulsion system.

The extended low temperature capabilities of Flexadyne propellants have been proven in numerous large-scale firings at Rocketdyne's Solid Propulsion Operations, McGregor, Texas. These tests culminated in the successful firing of a 38-inch diameter motor containing 3500 pounds of case-bonded propellant. This motor was fired at −75°F. after two-and-a-half complete cycles from −75° to +170°F.

Through research, engineering, and management, Rocketdyne is constantly at work to increase thrust performance and develop new propulsion techniques of both solid and liquid rocket engines. Other forms of propulsion also are under study: hydrogen-fueled engines, nuclear engines, ion engines, plasma jets, magnetohydrodynamic engines. The work at Rocketdyne is the most comprehensive production and development program being conducted on rocket propulsion in the Free World.

Rocketdyne's engineering skill and efficient production methods make it possible to power two missiles today for the cost of one in 1957.

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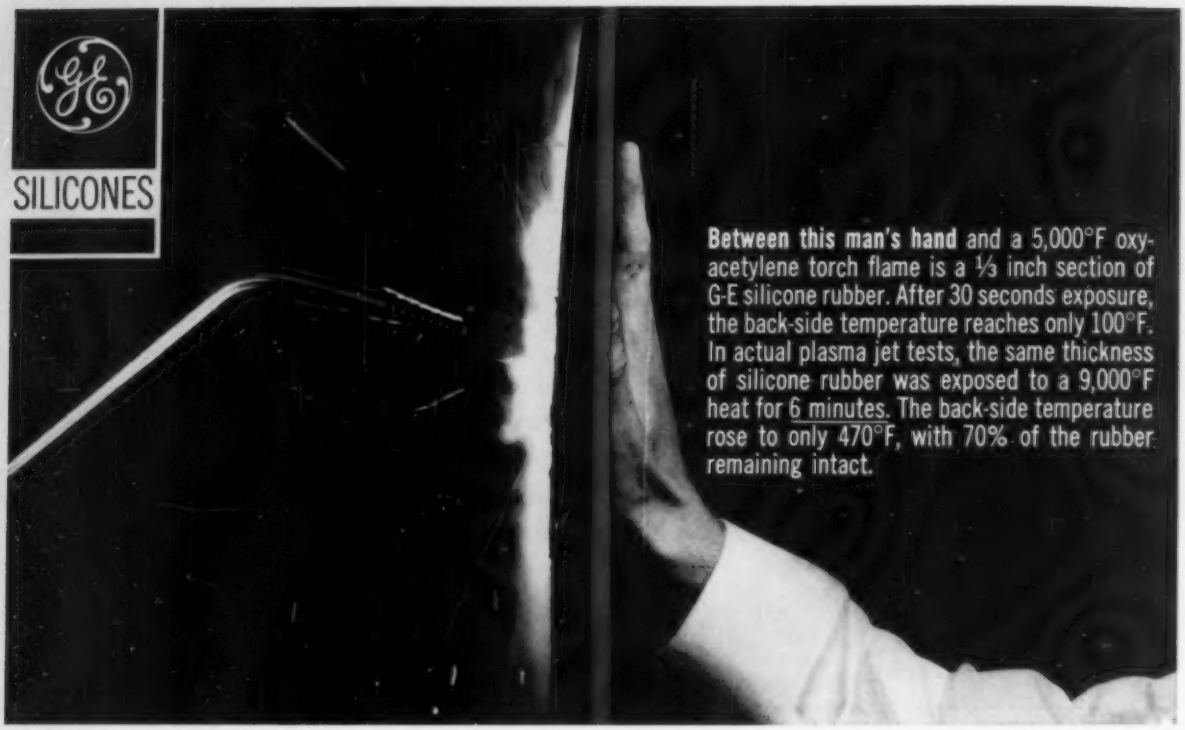
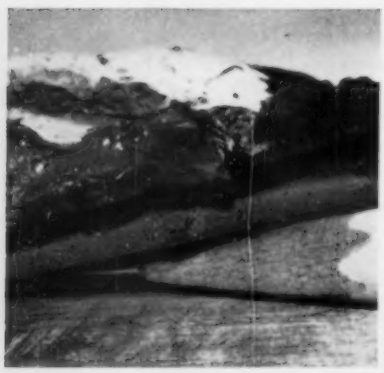


Between this man's hand and a 5,000°F oxy-acetylene torch flame is a ⅓ inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

Thermal barrier against 5000°F flame

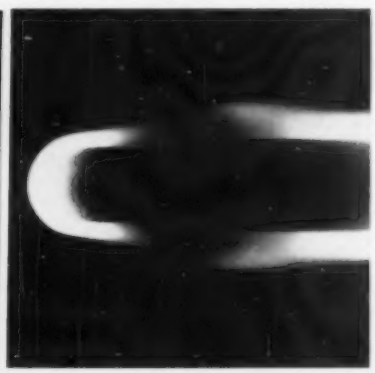
GENERAL ELECTRIC SILICONE RUBBER



RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation
Vel.=17,000 ft./sec.
Alt.=250,000 ft.

Exposure time at 9,000°F	Back-side temperature of ⅓ inch section of G-E silicone rubber
30 seconds	100°F
2 minutes	210°F
3 minutes	300°F
4 minutes	375°F
5 minutes	430°F
6 minutes	470°F



The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from —150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.

Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section 0961 Waterford, New York.

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Solution at hand for re-entry blackout problem . . .

(Continued from page 22)

cle. Given a velocity slightly different from that of the weapon carrier upon ejection, these fragments would move through space around the weapon carrier, making it extremely difficult for a radar data-gathering system to determine precisely which is the target.

Upon re-entry, many of the decoys would be screened away because of their low weight-to-drag ratio. Heavier pieces could be included among them, however, and these might follow the vehicle far enough into the atmosphere to reduce enemy interception probability.

Radar-absorbent coatings have possibilities, particularly for weapon carriers in vacuum trajectory, since these coatings will not be subjected to the intense heat encountered by aerodynamic vehicles.

However, it must be assumed that future techniques of radar data-processing will make it possible to sort out the decoys and identify the weapon carrier quickly. Also, detectors such as infrared sensors may provide the means for sorting out the decoy.

Because of these limiting qualities of such passive approaches, the main type of countermeasures for penetration aids will be active.

The rule of a tenfold system gain which applies to the defensive radar system does not apply to the offensive countermeasures system, according to Cooper.

Defensive radar systems, he says, will have increased their performance to the necessary level by increasing their radar power and the sensitivity of their antenna and receiver systems. Hence, at the radar there will be more radiated power, and considerably less received power, than is found at conventional radars directed against manned aerodynamic bombers.

Jamming equipment that would be fully effective in these circumstances stands midway between the limits of higher radiated power and less received power—in fact, says Cooper, pretty nearly where it is in ECM equipments of the present day. In other words, he believes the power needed to jam defensive radars operating against space vehicles will be of the same order of magnitude as the power used to jam radars operating against manned bombers today.

If anything, the necessary ECM power level will be even less, because the defense radar system in the Space Age will be a pioneer development, operating close to the minimum requirement, whereas the current anti-bomber systems have had a number of years of development and design improvement, and operate well above the minimum.

The conclusion, according to Cooper, is that the physical size of an active ECM system for a space vehicle will be well within a practical range.

• **Future systems**—Barrage and spot noise jammers, confusion and deception jammers, can be used effectively against missile defense radars in much the same way they are now.

Also in the offing is long-range scatter-jamming from the surface of the earth. The same tropospheric and ionospheric scatter phenomena now used in long-distance scatter conmmunications systems will be used to transmit microwave energy over the horizon. This might be useful as ECM for space vehicles because of the extreme sensitivity and wide coverage required of the defensive radars.

Also, as indicated earlier, the problem of communications blackout during the re-entry of a space vehicle may be solved by using a static magnetic field around the missile's antennas, according to Hallicrafters.

The feasibility of the static magnetic field approach was first advanced on February, 1960, by Henri Hodara, Associate Director of the company's R&D division. Since then, the approach has been expanded with further theoretical analysis and the design of a possible practical system.

The major finding of this advanced work is the fact that a static magnetic field of 500 gauss is sufficient to reduce the blackout significantly.

The original analysis, the company says, was based on plane-wave radiation through the plasma sheath. But according to Hodara, the plane-wave model is valid only as a first approximation.

It is accurate, he asserts, provided the plasma sheath is in the far field of the receiving and transmitting antennas. During re-entry, the sheath is in the near field of the transmitter, and its effect on the radiator's near field must be incorporated in the analysis; changes in the near field affect the radiation fields significantly when a plasma is present.

Recently, the radiation characteristics of long-slot antennas with a static magnetic field have been solved for the case of a plasma sheath in the near field.

Hodara's work on the radiation characteristics of long, narrow-slot antennas in the presence of a plasma sheath with an applied static magnetic field will be presented in detail at the National Electronic Conference in October.

Results obtained so far on radiation characteristics of missile antennas during re-entry seem to confirm the possibilities of eliminating the blackout through this approach, Hodara said.

Since the earlier space vehicles are expected to be unmanned, completely automatic ECM equipment will be used by the mid-1960's. Even after manned space vehicles become operational, they will have quite small crews who will not be able to devote more than a minimal amount of time and attention to ECM system control.

Other systems now in development or recently available:

—The voltage tunable magnetron developed by GE. Supported by the high-speed solid-state devices, it provides a countermeasures device of great agility.

—Sophisticated optical correlation methods. One major system has been built by Ling-Altec, others will follow.

—More effective modulation methods that can be used in the generation of jamming signals, available as penetration aids. (Results of a study by GE also will permit more effective use of the amount of power available for jamming and will help make jamming less susceptible to antijam devices.

—Pulse compression techniques. These are being developed by many companies for an ECM receiver that can give a very rapid digital readout of all rf signals contained in an octave of frequency.

—A new concept in expendable communications jammers. This is being explored for the Army. It can render enemy communications useless over a broad part of the rf band and at the same time over a large band area. The system reportedly has a negligible effect upon friendly communications.

—Thermoplastic tape recording. This appears to be ideally suited for ECM, reconnaissance, surveillance and repeater systems. Such systems are in advanced development now by several companies.

—Traveling wave tubes. These will find steadily increasing uses in the EW field for radar jamming over a broad frequency range. (One of the most advanced systems of this type is Sperry Gyroscope's new ALQ-27. Now undergoing tests by Air Force in a KC-135 jet transport, the equipment was to have gone into production this year, but the contract was reduced to R&D in an economy move last year.) ■

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EW BREAKTHROUGH

WHIP Receiver Is Claimed Accurate to 1%

Hallicrafters product, in final development, needs no active r-f devices, has perfect intercept probability

by Robert Hankin and Monte Ross

Research and Development Div.
The Hallicrafters Co.
Chicago

A HIGHLY VERSATILE ECM receiver, capable of identifying multiple radio frequencies to within one percent accuracy, will soon be available. It holds this accuracy over an octave of bandwidth without tuning and achieves an intercept probability of 100%.

Called the WHIP (Wideband High Intercept Probability) receiver, the radically new system is now in final development. Designed and being built by the Hallicrafters Co., it uses reactive transmission line elements to provide completely passive frequency determination.

The basic approach, which obviates the need for conventional active r-f devices—klystrons, magnetrons, voltage-tunable magnetrons and backward-wave oscillators—was suggested originally by scientists at the Stanford University Electronics Laboratory.

The WHIP receiver, developers believe, will provide a lightweight, low-cost system for reconnaissance satellites, airborne or missileborne "expendable" jamming, and laboratory studies of r-f interference problems.

• **Unique combination**—The basic WHIP receiver consists of a wide bandpass filter and a passive frequency discriminator, including two matched detectors, and can be employed with or without a preamplifier. Discriminator ouput can be displayed visually on a calibrated cathode ray tube or any properly calibrated oscilloscope. Frequencies are read out at angular lines in a manner similar for instrument pointers.

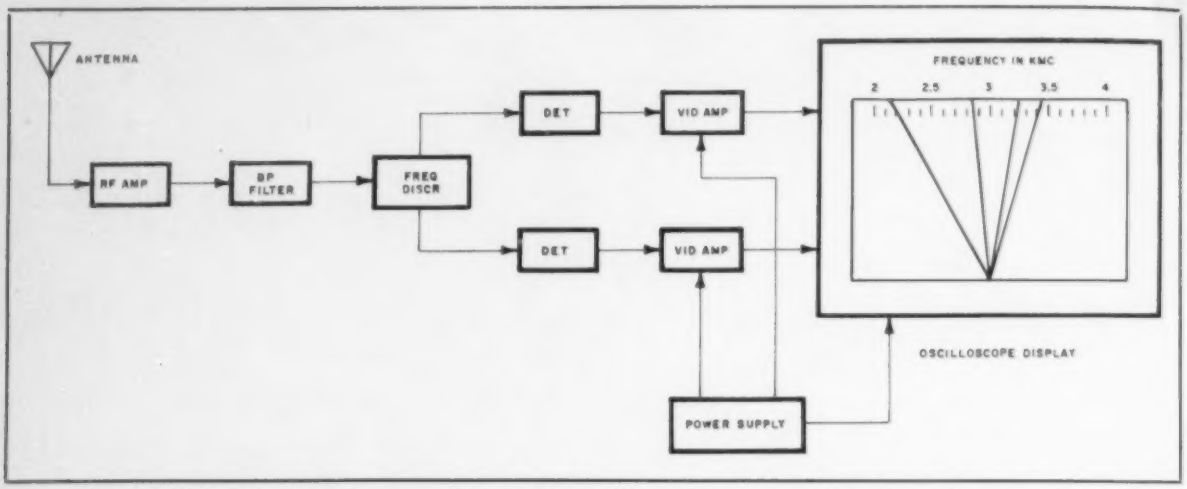
The multiple frequencies can be displayed simultaneously, providing the scope operator with an accurate picture of all frequencies seen by the receiver antenna, within the octave. When used in a reconnaissance satellite, the output of the WHIP receiver's detectors can be telemetered to ground stations and read out directly or digitized for feed-through to data gathering systems.

Unique among the receiver's many advantages is the fact that it gives frequency information over a broadband range of frequencies and at the same time gives 100% intercept probabilities. (Intercept probability being defined as detection of the signal when the system antenna is looking in the direction of signal emanation and the signal strength is higher than the system sensitivity.)

Normally, receivers may be divided

Comparison of WHIP Receiver Characteristics with Crystal-video and Tuning Receivers

	Crystal Video Receiver	Tuning Receiver	WHIP
Intercept Probability	100%	Variable but less than 100%	100%
Sensitivity	Good	Very Good	Good
Frequency Determining Ability	None	Very Good	Good
Power Consumption	Small	Largest by Far	Small
Size	Smallest	Largest by Far	Intermediate
Weight	Smallest	Largest by Far	Intermediate



BLOCK DIAGRAM of Hallicrafters Wideband High Intercept Probability receiver with oscilloscope display.

into two basic types: (1) superheterodyne or tuning receiver, and (2) crystal video receivers.

The tuning receiver, although it may be swept fast, may be at one frequency when a signal occurs at another frequency, thus not giving 100% intercept probability. However, it gives good frequency information.

The crystal video receiver, on the other hand, gives 100% intercept probability but no frequency information. Frequency information is obtained in many cases from crystal video receivers by use of a large number of filters; this adds complexity, weight and cost—and still does not give continuous frequency information, but only discrete portions.

The WHIP receiver provides the frequency-determining features of a tuning receiver and the intercept-probability capability of a crystal video receiver.

Complexity of receivers has in the past, continually increased as demands of more sophisticated performance grew. The WHIP receiver reverses this trend; it is much less complicated, requires less power, and is much smaller and lighter than usual frequency determining receivers. The small power requirements and the small size and weight make it especially suitable for airplane, rocket and satellite applications.

• **Favorable contrasts** — Detailed comparison of the WHIP receiver with the two basic types of microwave frequencies can be made in a simplified qualitative chart fashion as shown in the accompanying table.

Just as in standard crystal video receivers, sensitivity of the WHIP receiver can be considerably improved by traveling wave tube pre-amplifiers in front of the receiver. The specific sensitivity depends on bandwidth, frequency range, and component parts of all three types of receivers.

Power consumption of the microwave tuning receiver is much greater than the WHIP because an active r-f device is employed in tuning receivers. All of these use high power and high voltage for operation and constitute the majority of power used in these receivers.

The WHIP receiver employs no tuning but is wide-open over the band of interest. In addition, its frequency-determining elements are passive and require no power.

The WHIP receiver is much smaller than the tuning receiver because of the lack of an active r-f device. The passive elements used can be made small. Weight is much reduced for the same reason.

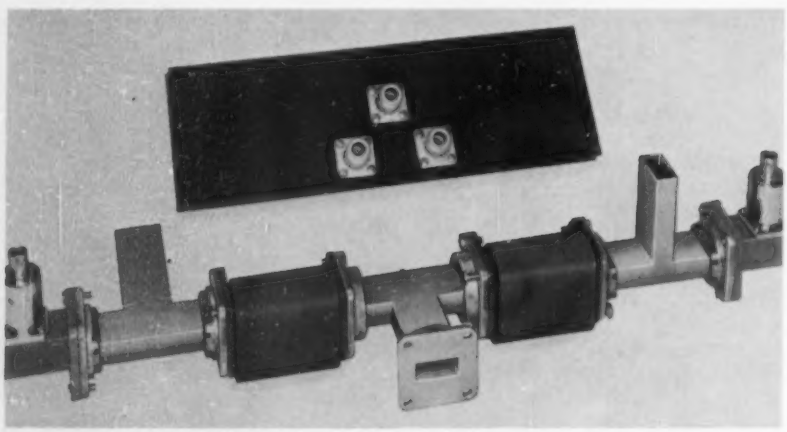
The heart of the WHIP receiver is the design of a broadband microwave frequency discriminator using passive sections and diode detectors only, exclusive of display or storage.

Several transmission line and waveguide frequency discriminators have been designed and built in the laboratory. Of these, one coaxial version has been tested at uhf and has exhibited good frequency resolution over the octave from 500 to 1000 megacycles. Another similar device designed in stripline has been operated over an octave in S-band.

• **Broadband potential** — An approach to the design of a brandband discriminator in the waveguide frequencies has been confirmed by the successful operation in X-band of a unit of somewhat different design. This discriminator uses waveguide sections and detectors, but due to the limitation of the waveguide bandwidth, has less than an octave range.

The broadband frequency discriminators can be used with a very simple oscillographic display that displays frequency as a function of the angle of a

(Continued on page 53)



COMPARISON IS SHOWN of uhf discriminator (top) and x-band discriminator (bottom) used in WHIP receiver. Such passive units permit detection of multiple radio frequencies to 1 percent accuracy.

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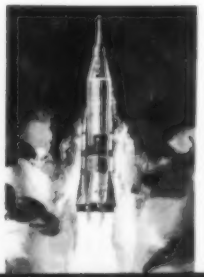

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Study Outlines Space Radiation Levels

For a 14-day lunar mission, the total unshielded radiation dose to which astronauts may be subjected from the worst combination of trajectory and sunspot cycle is about 159 rem. This estimate based on studies conducted at The Martin Co. by *Apollo* project engineers emphasizes, however, that the dosage from solar flare protons—the greatest potential threat to the spacecraft crew—can be more than halved by using 94 lbs. of close-proximity "spot" shielding. Further reductions can be achieved by "a small degree of internal equipment redesign" and the already considerable shielding afforded by the heat shield and the spacecraft structure.

Soviets Discuss Moon-Venus-Mars Projects

A two-stage space reconnaissance program—preparatory to manned flight—has been outlined in a brief article in Moscow's *Leninskoye Znamya*. The first stage—visual reconnaissance of lunar and planetary conditions with radio-telecontrolled electron telescopic apparatus—will send to earth thousands of photos taken from various altitudes. The second stage—physical reconnaissance of the lunar and planetary surfaces—will be achieved by mobile research laboratories and research stations with receiving and transmitting radio apparatus and instruments.

Retransmitting Satellite for Space Exploration?

For further radio communication with other planets it will be necessary to establish a satellite which will occupy an unchanging position relative to earth and Mercury and install on it a retransmitting station. This view—expressed by scientists in an article in the journal Automation, Telemechanics and Communications entitled "Radio Electronics and the Conquest of the Cosmos"—coupled with a description of the ion rocket's potential for "flights at a speed of 500,000 km per hour" gives an indication of the direction Soviet astronautics may be taking.

MATERIALS

Space Glider Gets Materials OK

Both materials and manufacturing processes essential to AF's space glider program are adequate for the job, according to the results of a $1.2-million contract just completed by The Boeing Co. Rene 41 and HS 25 were chosen for construction of the glider because of their superior strength and heat-resistant characteristics. The new processes required to machine these metals are also available, Boeing reports.

New Fabrication Method for Beryllium Presented

A new design concept using beryllium panels bonded to an aluminum substructure promises to minimize the usual difficulties with beryllium—including brittleness, high cost and toxicity. This is made possible, according to Boeing engineers, by the elimination of stress risers in the metal, the use of sheet material with little resulting scrap and no machining requirement.

Space 'Sandwich' for Solid Boosters Studied

Application of the sandwich structural design concept to solid-fuel rocket motor cases is being studied for the Air Force by North American's Space and Information Division. The research is divided into three phases: a feasibility study, construction and testing of subscale models and full-scale model tests with several static firings of the motor cases. The potential weight savings in large boosters is of prime interest.

PROPULSION

Ultra-Sensitive Thrust Measurer Delivered

A machine—so sensitive that it can measure thrust as gentle as one thousandth of a pound (about the force of normal breathing)—has been delivered to the AFSC at Wright-Patterson AFB by Rocketdyne. To be used to measure the thrust of ion rocket engines and other electrical propulsion systems, the machine can accurately measure thrusts up to 10 lbs. or any specified micrometric range in between.

ELECTRONICS

'Back Pack' Power Supplies Scrutinized

A study contract awarded to Atomics International by the Army Signal Corps. is expected to yield information for the design of portable thermionic power supplies using fossil fuels. The areas that will be studied include thermionic converters, heat sources and high-temperature materials. Atomics International has recently announced development of a flame-heated thermionic generator that burns a propane-air mixture.

Scatter Radar To Investigate Upper Atmosphere

Ground-based explorations of the upper atmosphere and outer space will be conducted by the National Bureau of Standards and the Instituto Geofisico de Huancayo at a new installation under construction 17 miles east of Lima, Peru. A 6-million-watt pulse transmitter and a 22-acre antenna with 9216 crossed dipoles mounted 6 ft. above a reflecting ground screen will be used to transmit a VHF wave for 50-1500 microseconds and then to detect the re-radiation of the pulsed radio wave by free electrons in the upper atmosphere.

NAA Studying Reflecting Materials for AF

The Air Force is sponsoring an examination by North American Aviation of the problem of putting special materials on the *Hound Dog's* skin to reduce its radar reflectivity. The three-phase study involves the determination of the materials to be used, their application to the missile and, finally, testing of the materials' effectiveness.

SUPPORT EQUIPMENT

Concern Voiced Over Dry Deflector Talk

Engineers at NASA's Marshall Center are concerned with rumors emanating from Washington that "dry" deflectors are being considered for *Saturn*-type launch pads. The concern arises from the fact that considerable sound attenuation is achieved just by the deflector coolant water. Without the water, according to one engineer, the static tests of the *Saturn* would have broken every window in the headquarters building—approximately a mile from the static test stand.

'Theoretical Formability' Praised

Cost-cutting concept described at AF-sponsored symposium; a report on other highlights of meeting

by John F. Judge

PHOENIX, ARIZ.—A new concept—theoretical formability—is expected to save time, manpower, tooling, materials and dollars in the production of missile/space hardware.

It was described to over 1500 industry representatives at a Materials Symposium sponsored here by the Air Force's Aeronautical Systems Division.

Called by J. Bryars of ASD "one of the most significant pieces of work being accomplished today," the method is essentially a means of bridging the vast gap between theory and shop in metal fabrication.

Theoretical formability correlates a metal's properties and the processes involved in forming it. Thus, major stumbling blocks such as limited design data, redesigns, improper materials selection and costly scrappage are eliminated. The most acceptable material can be selected and, by analyzing the material properties, the correct forming process can be chosen the first time.

For an example, Bryars picked a part having geometries allowing fabrications by either drop hammer or mechanical die.

The first inclination is to choose the least expensive process. But the analysis might show the job outside the drop hammer's capability. The mechanical dies operation, though more expensive, would produce the part the first time. The analysis will also specify forming at elevated temperatures if this is necessary, thereby guiding selection of tools and tooling materials.

There is nothing mysterious about theoretical formability. It grew out of the cleavage between purely theoretical and practical experimental work.

• **Failure system** — Basically there are eight major steps in the development of formability equations. The procedure depends on a thorough understanding of the forming process so that the parts and processes can be analyzed and the failure types determined.

When the part geometries relating to the failures have been determined, general failure limiting equations can be developed. The equation is next graphically portrayed and sample parts are selected and formed to empirically establish the curve's position. At this point a limiting curve for one process and material has been established and verified.

Means to relate the properties of one material to another are set up. These formability indices, once established and verified, can establish the position of curves for other materials. The last step is to finalize the equations into forms so that correlations between one material and another will be valid for selected geometrical and property parameters.

Once they have been performed, these steps need never be taken again for the process involved.

A current Air Force contract with Chance Vought Corp., Aeronautics Division, proves that the initial development of the formability limit equations and graphs were accurate.

Vought extended the concept to 12 separate forming processes and 19 aerospace metals. Not only are the graph shapes correct, but correlations show that the formability indices can predict the position of the graph for each material.

This means that materials properties obtained from simple tests can be used to predict formability limits.

Bryars says the work still has to be extended to all sheet-forming processes. The Vought work did not include some of the more complex shapes produced by several of the processes. Theoretical formability can be extended into the high-energy-rate-forming area, but a better understanding of these processes themselves would be needed.

• **High temperatures**—It also was pointed out to the meeting that the structural metals and refractories now being used in high-temperature applications have completely outstripped adhesives of equivalent heat-resistance. Current Air Force programs are targeted on developing such bonding materials; it is evident that organic adhesives will not meet advancing requirements.

F. W. Kuhn, G. P. Peterson and R. C. Tomashot of ASD attribute this to three obvious facts.

—Commercial resin and adhesive manufacturers who contributed their skills, facilities, and capital to develop the first adhesives adopted for military use have failed to qualify a single adhesive under a now 6-year-old specification. The principal requirement of 1000 psi tensile lap-shear strength at 500°F after 192 hours exposure is in itself but a token target in comparison with existing and future requirements for stable bonding materials at temperatures upwards of 2500°F for longer periods of time.

—Although contractual programs for modifying organic adhesives with inorganic additions have succeeded in extending the 8-day thermal stability to 600°F, the resultant initial and elevated temperature strengths have been materially reduced.

—Although programs of basic research to synthesize new chemical types of thermally-stable organic resins specifically for use in structural metal-to-metal adhesives have succeeded to the extent of producing resins having in themselves high softening points (above 700°F), the adhesives produced have exhibited poor mechanical strength even to exposures of only 400°F.

The most fertile field for bonding materials seems to be in the ceramic adhesives area. Their main disadvantage, brittleness, is slowly giving way as research efforts continue.

• **Flash joints** — Another unique method for joining metals has recently been adapted to sandwich construction. The process is called the "Exo-flux Method." The prefix refers to an exothermic-reactant composition which, when applied to, and ignited on, the external surfaces of the metal to be joined, imparts an intense heat of short duration. This flashing, imparted to a metal oxide fluxing agent and element metal donating material which has been previously within the bondline, forms

a strong adhesive joint with a continuous metal phase.

Under these conditions of firing, the metal oxide of the fluxing agent releases its metallic portion to form a eutectic with part of the base adherend metal. Kuhn and his associates say that no attempts have been made other than with stainless steels such as 17-7PH, PH15-7Mo, AM-350, AM-355, A-286, A-302, and A-321. The method promises to be adaptable to the bonding of higher-temperature alloys such as Inconel X and Rene 41.

A final significant point is that the method adds relatively negligible weight to a structure. It takes 0.006 lb. per square foot of Exo-flux compared to 0.3 lb. of standard average brazing alloy for the same area. Patents have been filed on the process.

Two other specialized adhesive areas were mentioned. One is the development of room-temperature curing agents for field work and the other covers cryogenic needs in adhesives. Organics hold promise in the latter.

• **Oxidation coatings** — N. M. Geyer of ASD finds the current refractory metal-coating technology somewhat disproportionate. A high degree of effort is still being devoted to optimization, scale-up and establishment of reliability for molybdenum coating for re-entry purposes. No single coating for columbium is as fully advanced as the pack-silicide coating formolybdenum, but at least three—the vacuum vapor Cr-Ti-Si alloy, the slurry aluminide and the pack-silicide—appear promising.

Tantulum coatings are comparatively new and unexplored. No coatings for tungsten have progressed far beyond laboratory feasibility studies.

The standardization of coating evaluation procedures remains a major problem area. Geyer says this task should be relegated to design and applications engineers for testing against specific design requirements.

There is a continuing need, says the Air Force scientist, for related efforts in support of coating development. Since direct effort developments are made on a basis of meeting immediate requirements, it is probable that resulting coatings will suffer disadvantages necessitating design compromise.

These areas should include both investigations of feasibility of various application techniques to form classes of coating compositions and the development of alternate techniques to form specific proven compositions. The problems of ductility and self-healing should also be handled.

A wide spectrum of fundamental investigations is needed to support intelligent coatings studies. The mechanisms of oxidation in refractory metals and in the coating themselves, the nature and chemistry of oxidation products, and the deterioration of coatings by physical processes are weak points in current U.S. programs.

• **Electronics limited**—Further advances in electronics are highly dependent on materials technology, F. E. Wenger, Air Force Systems Command, told the symposium. He said the greatest current problem is the reliability of electronic equipment. Contemplated future military and space functions cannot be accomplished with equipment having mean time to failure of only 1000 hours.

This period must be extended from 10,000 to 100,000 hours. Since future electronic systems will be designed with functional blocks, any failure will be a materials failure, he said.

The long time requirement means that certain materials used in parts or subsystems must have failure rates less than 0.0001% per 1000 hours of operation. Wenger said the attainment of such reliability must be based on an understanding of the materials and processes involved. This is something entirely different from mere running of tests.

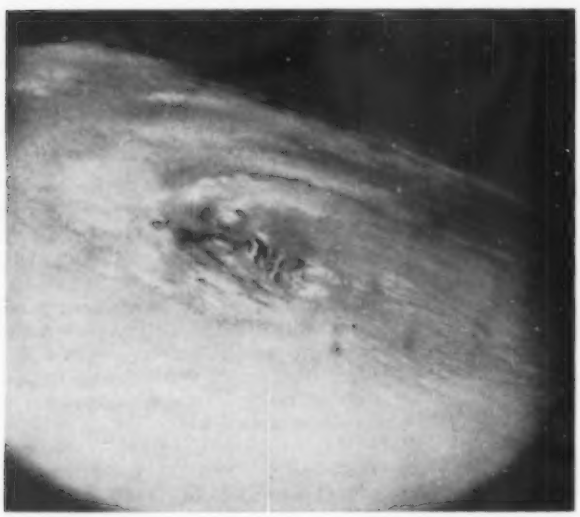
The materials specialist said the U.S. is becoming a nation of research followers rather than a nation of independent thinkers. Some of the vast research energy devoted to silicon and germanium in solid-state work should be funnelled into searching for new phenomena.

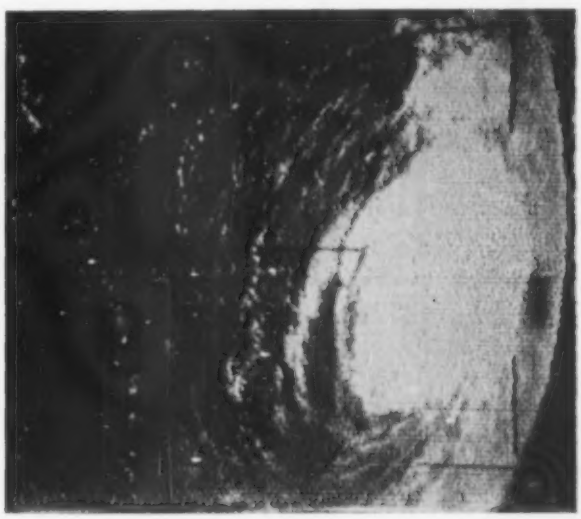
"It would appear that one of the payoff efforts would be to forget about electronic construction as we know it today, break down electronic functions into various phenomena such as generation, amplification, mixing, modulation, demodulations and display—and synthesize black-box electronic functions from physical processes," Wenger said.

Wenger maintains the problem of material for electrically transparent housings such as radomes has never been adequately solved. Basic work is a must on alloys that act as superconductors at normal temperatures without the basic materials being superconductive. Superconductors exhibiting magnetic properties are needed.

Flexible ceramics with high insulating resistance in the microwave area

(Continued on page 46)





'Debbie' Snapped Twice from Space

EYE OF HURRICANE "DEBBIE" shown in photo taken from Mercury Atlas-4 spacecraft 12 minutes after it was launched on earth-orbit flight Sept. 13. MA-4 took about 360 photos.

EARLIER PICTURE of "Debbie" was taken by NASA's Tiros III weather satellite when storm, not yet of hurricane force, was 2500 miles east of Miami—25 degrees N, 42 degrees W.

PRISM to Be Used on Missile Ships

Maintenance management method, big success in gunfire control system, is efficient and flexible

by William Beller

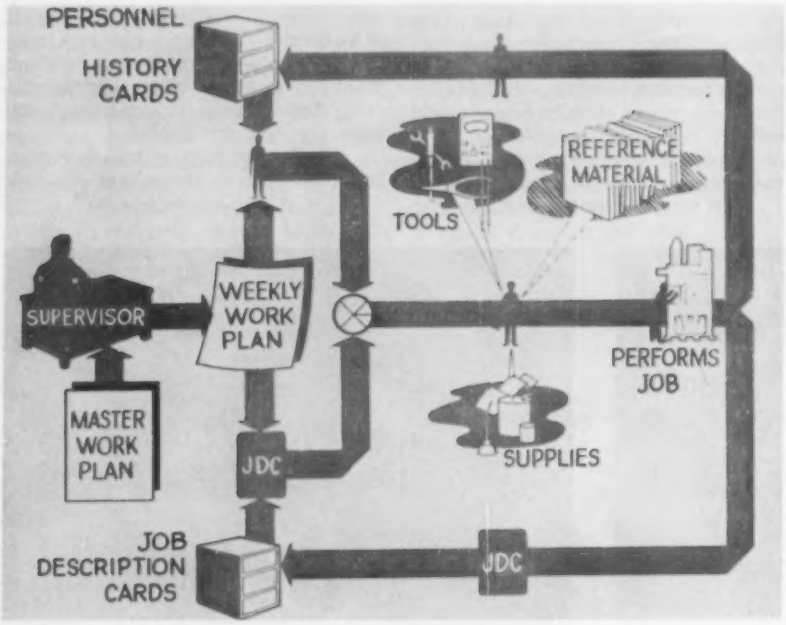
THE NAVY is introducing a new maintenance management concept aimed at ensuring constant readiness of the Fleet's weapon systems.

All ordnance systems on guided missile destroyers of the DDG-2 class—which carry *Tartars* and *ASROC's*—are being studied preliminary to installation of the concept, called "PRISM."

The idea was first tried out on the Navy's Mark 56 gunfire control system, and worked so well that it is now being tailored to fit the more modern Mark 68 system.

PRISM stands for "Programed Integrated System Maintenance." (It is not related to a "reliability" concept which has the same acronym and is an offshoot of the management tool PERT.)

It is designed to arrange the bits and pieces of the maintenance jigsaw into a picture that management can recognize and work with. It can be used in any weapon system—and on commercial equipment—which requires periodic maintenance, and its devisers say that it rapidly becomes more useful as the maintenance problem becomes more complex.



How The Maintenance Loop Works

(1) The local supervisor consults the Master Work Plan, determines what tasks are to be performed during the calendar week, and lists these in his Weekly Work Plan. (2) The supervisor selects Job Description Cards for the particular tasks to be performed during that watch, day, or shift. (3) The supervisor consults the file of Personnel History Cards and assigns personnel. When personnel and JDC's are "married", tools and supplies may be selected, reference material examined if necessary, and the job performed. (4) Feedback after the job is performed is in two patterns: The performance is noted on the Job History Card as the JDC is returned to file; the performance by personnel is noted on appropriate Personnel History Card.

Furthermore, PRISM lends itself to being expressed on a computer; managers at any level will be able to "read out" current capital-equipment readiness, in much the same way they can learn the status of a research and development effort through the computerized PERT. (M/R, July 17, p. 110).

Benefits of PRISM are said to be these:

—It identifies and keeps track of the maintenance jobs to be done.

—It recognizes immediately jobs that cannot be done with the facilities on hand.

—It clearly describes and standardizes maintenance jobs.

—It relates the maintenance job to the minimum skill needed to do it. In this way, highly skilled workers are made more freely available for work requiring their special abilities.

—It acts as a filter, straining out unimportant jobs. For example, shipboard personnel are not given maintenance jobs that do not contribute to the ship's mission.

—It makes paper work simple and economical—four records being all that are needed.

—It provides material for training programs; in fact, it is said to serve well for on-the-job training.

• **Antecedent** — The forerunner of PRISM was developed eight years ago aboard the USS Des Moines by Chief Fire Control Technician C. E. Satterwhite. Accordingly labeled "Satterwhite Method," it consisted of job description cards which outlined and scheduled shipboard maintenance operations. Later, the system was adopted by the Bureau of Ordnance for general use throughout the Fleet.

In 1958, the Satterwhite Method was enlarged into the comprehensive system now known as PRISM. The job was done by Jerome E. Levy, and his Washington Engineering Services Co., a Bethesda, Md. firm. Levy had been an employee of the Bureau of Ordnance, where he worked on many of the problems connected with shipboard

fire-control performance and maintenance.

Levy's company is now heading the military-industry team developing PRISM for DDG vessels.

At a recent Fleet Maintenance Conference in Norfolk, a representative of the Chief of the Bureau of Naval Weapons said that PRISM not only provides maintenance that fits operational requirements but also "provides maintenance oriented to the needs of the machine dictated by its design, and the needs dictated by the mission."

He also said that "PRISM for the DDG will integrate existing Satterwhite coverage into a comprehensive plan which will include all DDG ordnance systems." One of the sparkplugs in bringing this about is E. L. Meehan, the Bureau's Chief Maintenance Engineer.

In general, PRISM calls for (1) an appraisal of the maintenance work that has to be done to fulfill a mission; (2) an examination and description of how the work is to be done; (3) an organized approach to doing it; and (4) a constantly current report on the maintenance readiness of all capital equipment.

• **How PRISM works**—The basic PRISM loop is illustrated in the accompanying chart.

The *Job Description Card (JDC)* is fundamental. Made of a tough plastic so that it will not wear out when referred to on the job, this card contains all the information a man needs in order to do his maintenance chore. Moreover, it calls for one of three grades of maintenance skill, starting with that possessed by the relatively inexperienced man.

Information for the JDC cards is obtained by professional maintenance men who study the maintenance problem, interview manufacturers and others concerned with the equipment, and watch the various maintenance jobs being done. On-the-spot pictures are taken with a Polaroid camera. These illustrate the maintenance job and add a realism and practical approach that is difficult to get with the usual engineering drawing or isometric.

The JDC's are one of four records comprising PRISM. The others are the Job History Card, the Weekly Work Plan, and the Personnel History Card.

Every Job Description is mated with a *Job History Card*. Accordingly, each Job History Card tells the state of maintenance of a piece of equipment.

Once a week the man who assigns the work enters on the card the date (the week beginning), the interval at which the job is performed, the name of the man assigned to the job, whether or not he has previously been qualified, pertinent remarks (particularly if a casualty was discovered), and his initials to verify that the job has been completed for the week.

A Master Work Plan appears in front of each set of Job Description Cards covering a particular weapons system. The Master Work Plan lists by JDC number and, by weeks, the schedule for performance of the maintenance jobs for each of the 52 weeks of the year. In addition, a *Weekly Work Plan* is made up and posted to inform all hands of the maintenance jobs they are to perform during the week.

Lastly, there is the *Personnel History Card*. This tells what jobs a maintenance man has done, how well he qualified for them, and thus whether he is qualified for more difficult and varied assignments.

• **Highly adaptable**—The PRISM system has sufficient flexibility to adapt itself to changing conditions. For the Navy, for example, PRISM offers a convenient way to catch up on maintenance work after an enforced layoff due to weather, shore leaves or wartime activities.

A similar situation might arise in industrial plants that have been closed or running slack because of a company-wide vacation, strikes, or seasonal variations in employment.

In such instances, when normal operation is resumed, the first Weekly Work Plan is taken from the week that appears on the Master Plan immediately after the last week that was worked. That is, if there was an enforced layoff for three weeks after the work in the 14th week in the Master Plan had been performed, the first week's work after resumption should be based on the 15th week on the Master Plan and not on the 18th week. In this way, no annual, semiannual or monthly jobs will be neglected.

When a short week occurs, and not all the jobs scheduled for the week are performed, the annual, semiannual and monthly jobs are carried over to the next week.

PRISM is not an automated panacea for the problems of maintenance management. This is emphasized by Levy and many of the men connected with the concept. "PRISM," they say, "does not provide for its own adoption." This must be done by managers seriously interested in an organized maintenance program.

Furthermore, once PRISM is instituted it must be kept up to date by the people doing the maintenance work, the work sheets must be carefully prepared and constantly monitored by the managers, and maintenance "exceptions" must eventually be brought into the fold. ⌘

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More funds to be sought . . .

Houston Lab to Be Complete in '64

NASA's Space Task Force to move in after Mercury orbital series is over; Gilruth is possible choice for director

NASA's $60-million Manned Space Flight Laboratory, to be located in Houston, Tex., is scheduled for completion in late 1964—well in advance of major flights in the *Apollo* program.

Space Agency officials report that some of the major buildings at the site will be completed within 18 months, with construction of the others expected to take from 26 to 36 months. Announcement of the location was made last week.

The laboratory, located on 1000 acres of land made available by Rice University in Harris County, will be the command center for the U.S. manned lunar landing mission and all follow-on manned space flight missions. It will be utilized to design, develop, evaluate and test the *Apollo* spacecraft and its subsystems, as well as to train the crew for the missions.

NASA's Space Task Group, currently located at Langley, Va., will move to the new facility as soon as the *Mercury* orbital flight series is completed. While no announcement has been made, it is expected that Dr. Robert C. Gilruth, current director of the Space Task Group, will head the new laboratory.

NASA has funds in its Fiscal '62 budget for the development of the site and the construction of four integrated facilities: a flight project facility, an equipment evaluation laboratory, a flight operations facility, and an environmental testing laboratory. NASA officials report that more funds for expansion of the center will be requested in the Fiscal '63 budget and that further expansion will take place to meet the need for very large vehicles for interplanetary exploration.

A breakdown of the four facilities in the laboratory follows:

• **Flight Project Building**—To house the executive offices, project engineering offices, flight systems offices, and central management services, an eight-story, $12,000,000 facility is planned. The building—providing approximately 340,000 square feet of space—will serve as the management, engineering and service center for the Manned Space Flight Laboratory.

In addition, a scientific library, central reproduction facilities and the centralized computing and data systems will be located in this building. Conference and briefing areas will be provided for staff meetings and briefings of contractors, scientists and military personnel involved in the project. A fallout shelter is also included.

• **Equipment Evaluation Lab**—The Equipment Evaluation Laboratory and Support Facility provides the central services complex, including the shop and assembly areas for the preparation and repair of *Apollo* models and other equipment. The proposed buildings will be of standard mill-type construction, with offices convenient to the shop and laboratory areas.

In the equipment evaluation laboratories, capabilities and performance characteristics of the components and systems will be thoroughly tested to insure the high reliability required for manned space flight.

Also housed in this facility will be the maintenance facilities, procurement and supply activities including a stockroom, shipping, receiving, and warehouse areas and budget and finance activities.

To cost some $13.2 million, the facilities will provide approximately 142,000 sq. ft. of offices—64,000 for shop and assembly bays and 64,000 for the equipment evaluation laboratory.

• **Flight Operations Facility**—Consisting of a three-floor, 50,000-sq.-ft. office section abutting the laboratory and training facility area of approximately 70,000 sq. ft., the $3.6-million Flight Operations Facility provides an integrated center for the required mission simulation, as well as training equipment for the flight operations and training groups.

Part of the laboratory area will comprise a flexible arrangement of components for mission simulation. Among these will be:

—A display of the navigational environment to the navigation systems and components and/or pilot in either inertial or vehicle coordinates through the arrangement of suitable optical projections and screens.

—A test platform in the navigational environment capable of large-angle low-friction motions.

—A test chamber in which man-machine relationships would be evaluated in the internal environment of a space capsule.

—Function generators and associated apparatus for appropriate synthesis of vehicle, system and/or trajectory parameters, for the control of field and platform motions and for integration of the motion, field equipment and manual elements into a dynamic simulation of the flight mission.

—Instrumentation, data-handling devices and associated apparatus for general support of navigation and control tests.

These training facilities, however, will be supplemented later with training devices more closely oriented to the manned flight mission.

To aid in evaluation of space navigation techniques and components, a navigation and control dynamics simulator will be built. It will provide a means for evaluation of the requirements and performance of navigation, stabilization and control systems and components.

A simulator of this type allows effective evaluation of the man-machine relationships essential for the lunar landing mission.

• **Environmental Testing Laboratory**—Facilities for testing the full-size *Apollo* spacecraft under critical in-flight environmental stresses will be provided in this testing complex. The main section of the building—a 100,000-sq.-ft. area—will provide for orderly spacecraft preparation, instrumentation, environmental testing and data handling. Adjoining the lab will be a two-story, 30,000-sq.-ft. office area and a submerged test cell of approximately 4000 sq. ft.

Within the laboratory area, two large thermal-vacuum chambers will subject the *Apollo* modules and assemblages to the pressure and temperature environment of space.

The first cell—100 feet in diameter and capable of handling the complete *Apollo* vehicle with extended antennas and solar arrays on a gimballed mounting system—will permit manned operation of the spacecraft under test. The

chamber's design includes pumping facilities to permit evacuation to 10^{-5} mm of Hg within 24 hours, sufficient capacity for operational test periods of about 500 hours, solar heat radiation simulation of 130 watts per square foot over a 50-ft.-diameter circle, and temperature control to simulate space temperatures and the planetary albedo.

The second chamber will be closely integrated with the first to provide maximum use of common support equipment. Approximately 60 feet in diameter, this cell will accommodate the spacecraft modules with space simulation capabilities paralleling those of the larger chamber. Due to its smaller size, however, it will allow better simulation of ascent pressure changes and attainment of high vacuum in a shorter period of time.

• **Ancillary Testing Equipment**—Also included in this facility will be the control centers for monitoring and effectively operating the thermal-vacuum chambers and the data-handling equipment associated with them. Other support equipment located in the laboratory will be:

—An arrangement of backstops, tie-down points and loading and load distribution apparatus for static loading tests.

—A centrifuge for inertial loading use.

—A scaled group of shakers with complex wave-drive systems for dynamic loading tests.

— Shock and impact test apparatus, as well as sound generators controlled by the shaker drive systems, to permit environmental testing of spacecraft structures in the high acoustical fields associated with the boost phase of launching.

—Quartz tube-type heating elements with a programed control system to permit spacecraft structural evaluation in high-temperature environment.

—Test instrumentation (data-handling apparatus and related auxiliary equipment) to support test programs.

The overall cost of this facility is expected to be $26,482,000.

• **Site Improvement**—NASA has allotted a little over $4.5 million for site development and utility installations. This includes clearing and grading, a basic road system, security fencing and street lighting, and an electrical power system.

The latter would be composed of a substation and distribution lines for 20,000 kva backed up by a 1000-kva emergency motor generator station, a central heating plant and chilled water and air-conditioning system, a sanitary sewer and storm drainage system. ⌗

IBM Chosen to Build Thin-Film Production Line

FIRST SERIOUS attempt to develop an automated high-volume production line for thin-film subassemblies will be made by International Business Machines Corp.

The Navy announced last week the award of a $506,861 contract to IBM's Federal Systems Division to develop and build one pilot production line capable of continuous vacuum deposition. The production goal, using wafer substrates, will be to achieve a rate of over 200 square inches of thin-film electronics subassemblies per hour.

Work will be performed at Federal Systems' Command Control Center, Kingston, N. Y. With its own funds, the company also will build a duplicate production line to further advance its in-house thin-film R&D effort.

Technical guidance for the one-year program will be provided by the Bureau of Naval Weapons, Naval Avionics Facility (NAFI), Indianapolis, Ind.

• **The need is urgent**—As evidenced by the unusual coverage given this field by the trade press over the past several years, there is an urgent need for making electronic systems more reliable and rugged and at the same time reducing their size, weight and power. With system complexity has come burdensome size and intolerable power and cooling requirements.

The move to solid-state systems was the first successful frontal attack on the problems.

The broad use of thin-film circuits, providing even more reduction in power needs and at least a magnitude increase in parts-density capability, is widely believed to be the next logical step toward solution of the industry's design troubles.

Even with the advent of truly functional circuits or subsystems, scientists say, thin-film subassemblies will complement their use as supporting building blocks for next-generation electronic systems.

• **IBM's approach**—In the fabrication of thin-film components, various materials—each chosen because of its particular electrical properties—are vaporized by heat in a vacuum container.

In turn, each vaporized material is deposited through a mask or stencil carefully fitted over a base or substrate. Thus, a complete thin-film subassembly can be built up in layers by precisely controlling deposit location, sequence, shape, and thickness.

By properly arranging conducting and non-conducting materials and integrating these with appropriate semiconductors, conventional electronic functions can be performed.

The IBM-NAFI problem will be to design and integrate the deposition equipment, controls, and monitors necessary to move present technology from the laboratory to the production facility.

IBM has indicated that it will employ a fully automatic line composed of four vacuum chambers, with access to each provided by airlocks. A transport mechanism will carry substrates from chamber to chamber.

Substrates will be masked automatically in the furnaces; temperature and time will be controlled accurately throughout the deposition period. The process continues in each chamber until all the required layers have been made.

For batch fabrication, the chambers can be separated.

To achieve high standards of purity, reproducibility and parts uniformity, IBM says, a chemically-inert high-vacuum process will be used.

• **Mandatory use someday?**—The Navy says the new facility will be used to evaluate thin-film technology. It may also lead to a requirement that such techniques be used in the future for Navy electronic components and systems.

Following successful completion of the program, the Navy says, it will encourage other manufacturers to install similar production lines as part of its (BuWeps) industrial readiness plan.

IBM said it will either market the thin-film production equipment or establish one or more sources for marketing and fabrication of the system.

NAFI plans to use the equipment to produce thin-film devices for use in highly advanced experimental electronic equipment. These will include missile guidance systems, satellite instrumentation, data processing equipment and communications systems. It is with these devices, said Navy, that savings in weight, volume, and power are extremely vital.

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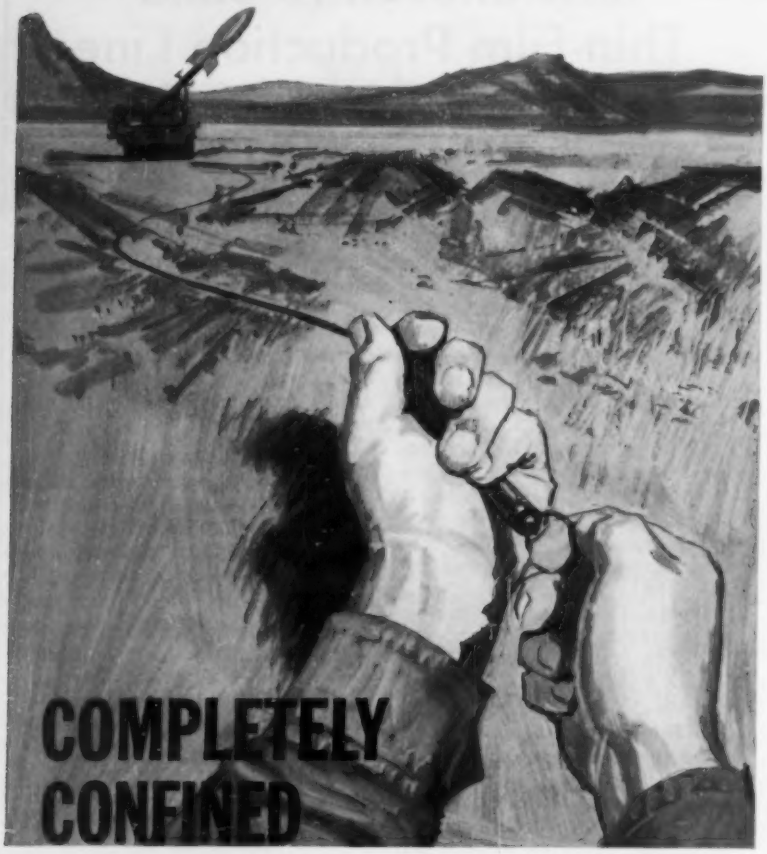

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Materials Symposium

(Continued from page 41)

would be a worthwhile project, according to Wenger. There is a desire for specialized materials for specific application which do not need doping.

The day of the simple glass-enclosed electron tube is nearly over. The new tubes of Air Force interest are practically complete electronic subsystems needing in most cases only a power supply and an antenna.

Many tubes require external magnetic elements to control the path of electrons flowing within the tube. Wenger lists some of the requirements:

—Coercive force: The need is for a constant or nearly constant coercive force versus temperature curve.

—Nuclear radiation: Most high-coercive-strength material contains cobalt, which has a long half-life. The need here is for a material which does not retain radioactive properties after exposure.

—Periodic focusing: The Alnico series so far have not been usable to periodic focusing of traveling wave tubes. Ferrites have been used extensively. The need is for a lightweight material with Alnico's flat coercive force versus temperature characteristic and the ferrite's machinability and ability to retain magnetic field under shock and vibration.

Other tube problem areas outlined by Wenger include:

—Study of high-strength metal whiskers for storage screen mesh in image tubes.

—Study of high-strength dielectric material whiskers for storage mesh in memory tubes.

—Study of Electrets for memory tubes.

—Study of single crystal selenium and other possible materials of high resistive properties for EBIC Camera Tube.

—Study of secondary emitting properties of materials used in imaging and memory tubes.

—Study of photo emission.

—Study of electron bombardment induced conductivity in dielectric materials for imaging and memory tubes.

—Study of material photo-emissive in visual octave and photo-conductive to the infrared octave of the electromagnetic spectrum.

—Search for anisotropic resistive material for use in image storage tube targets.

—Search for anisotropic material as a substitute for fiber optics and as a substrate for photo sensitive-phosphor sandwich used in image amplifier tubes. ⌗

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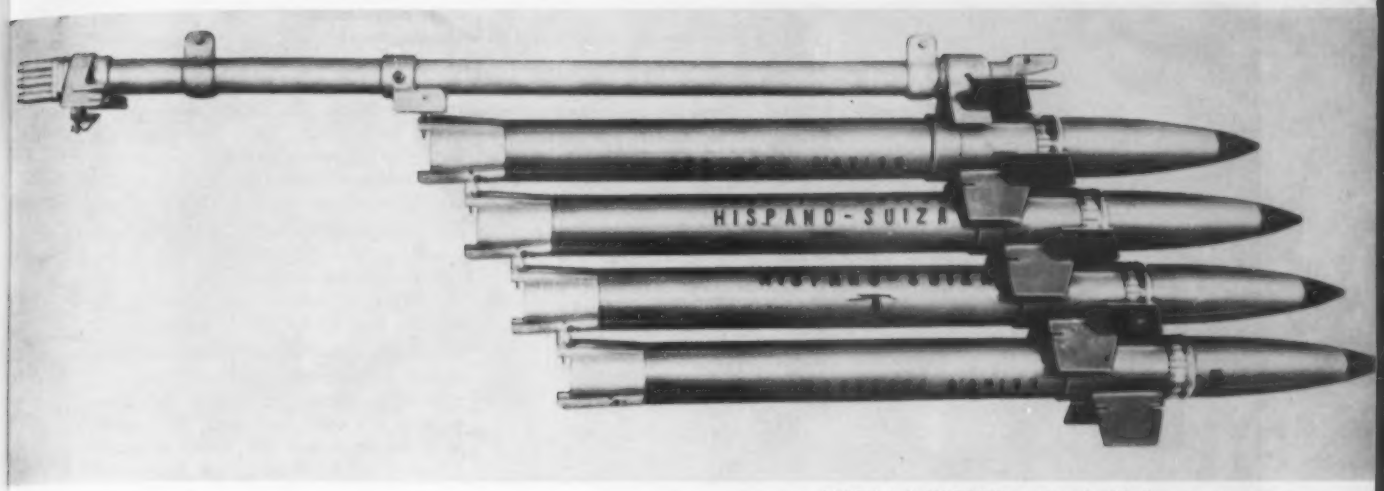


NATO LAUNCHER equipped with Sura suspension devices. Simplest arrangement is stacking in tiers.

international

Swiss Rockets Fit NATO Launchers

Hispano-Suiza's Sura series has simple suspension arrangements for Mach 1 planes supporting troops

by Bernard Poirier

AIR-LAUNCHED ROCKETS, prime requisites for ground troop support, have been adapted by most European manufacturers to fit the NATO launcher first and their own systems second. The *Sura* rocket series by Hispano-Suiza of Switzerland is no exception.

The 3.15-in. solid *Sura* R80-A is fitted with 12-in. fins which slide along most of the rocket's 43.2-in. frame. A standard 23.1-lb. *Sura* carries a 4-lb. warhead including a 2.2-lb. explosive charge. A hollow charge is also available.

For practice firings, both the smoke charge and the dummy head have the same ballistic properties as the standard war-rocket. From an aircraft flying at 497 mph, a 50% height and width dispersion of about 10 milliradians is obtained.

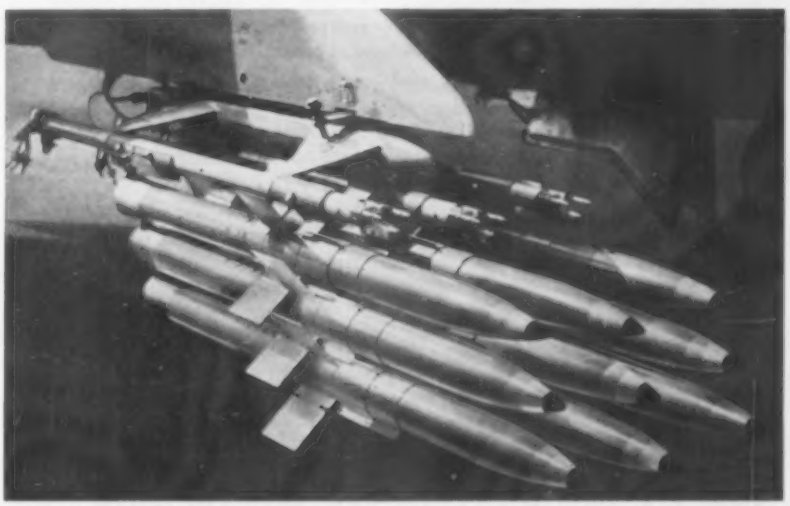
When the rockets are fired from a ground test ramp, however, dispersion is slightly increased because of the absence of aerodynamic stabilization.

Propellant ignition is triggered in .01 sec. under 2.5 amperes. A normal voltage of 24 volts dc and internal .3 to .6 ohm resistance of the motor gives greater current. At 15°C, combustion duration is .6 sec. with interior pressure of 418 lbs/cm². Combustion temperature is rated as 3000°C and thrust at 2640 lbs.

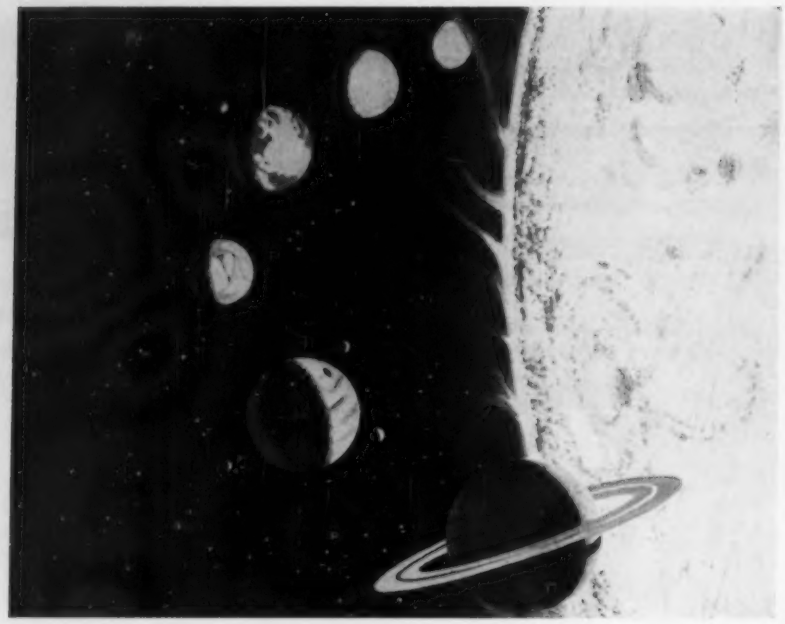
An increase in initial temperature, producing higher pressure and thrust, shortens combustion time. A temperature decrease has an opposite effect, although the impulse suffers no significant change—its value remaining around 1540 lbs./sec. Best functional temperature range is −40°C and +50°C.

Rockets are carried and fired according to the aircraft's design. Most commonly, they are hung under the wing in the open, fitted in containers under the wing, or fitted in the fuselage. The simplest European suspension stacks one rocket below another in tiers.

• **Simple style**—One Hispano-Suiza (Suisse) design requires no wires and no launcher, and has only two fittings attached directly to the wing to accommodate the top *Sura* rocket. The sliding fins serve as front suspension element prior to firing. The rocket frame then slides through the fins until the motor



HISPANO-SUIZA'S Type R-80 Sura aircraft rockets on Fiat G-91 attack fighters, a Mach 1 aircraft. Mach 2 planes require rocket containers and folding rockets.



Outstanding new opportunities for:

AEROSPACE SYSTEMS ENGINEERS AND SCIENTISTS

Continued expansion of our aerospace systems programs has created additional openings for highly qualified engineers and scientists to participate in company studies on many advanced projects. Challenging positions now exist in the following areas of specialization:

SPACE TRAJECTORY ANALYSTS To conduct studies leading to optimum flight techniques, propulsion requirements, trajectory sensitivity, and guidance and control requirements for a wide variety of space missions. Interception and rendezvous, orbit station keeping, lunar missions, and deep space probes are all under study. Openings exist at all levels for conducting sponsored research programs and for supporting advanced system studies.

ATMOSPHERIC FLIGHT TRAJECTORY ANALYSTS To determine flight performance and control characteristics for all phases of earthbound flight. Missions to be analyzed include ballistic flight, cruise in atmosphere, and recoverable boosters, but major emphasis will be on techniques of re-entry. Familiarity with analog and/or digital techniques is desirable. Openings exist at all levels.

FLIGHT CONTROL ANALYSTS To conduct research programs in new techniques of controlling large areo-elastic airframes and manned re-entry flight vehicles. To develop accurate and efficient attitude control system concepts for spacecraft. To determine automatic control system requirements integrated with airframe, propulsion system, and man in the loop. Openings exist at all levels.

NUMERICAL ANALYSIS AND DIGITAL PROGRAMMING Engineers required who are familiar with one of the above problem areas and who desire to take intensive training in FORTRAN digital programming. Mathematicians required to perform numerical analysis studies leading to optimum problem solution techniques by digital means. IBM 7090 available, also smaller computers for personal experimentation.

For additional information, please address a resume or letter of inquiry to:
Mr. B. J. Cunningham, Manager, Employment Services,
12214 Lakewood Blvd., Downey, California

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

SPACE & INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

tube picks them up at the conical end where they remain as stabilizers.

Rear suspension is provided by a flap on the high rocket which also fixes the one below. On firing, the exhaust opens the retaining device and blows the flap into the recess of the upper rocket. This action transfers the ignition circuit automatically to the next rocket above.

This Hispano-Suiza design adapts easily to the NATO launcher where standardization is demanded for use in the Mach 1 range, such as with the NATO Fiat G-91 attack fighter.

Mach 2 aircraft require rocket containers to cope with resistance and drag within standards of stiffness. Folding rockets are used with such containers. Hispano-Suiza has the *Lesca* series to compete with offerings of Hotchkiss-Brandt, Bofors, Oerlikon and others.

Effective close-in support of ground troops is better served by the slower-class aircraft. To raise probabilities of greater accuracy, Hispano-Suiza compromised in favor of velocity over payload; the resulting higher speed increases accuracy and cut flight time against tanks, armored cars and other moving objects.

The Swiss company points out that unguided rocket tests have demonstrated that, despite advances in guided missiles, suitably designed free-flight rockets still provide one of the best methods of close-in support.

These rockets, fired in bursts of several birds, give a high rate of kill per dollar invested and are not likely to be replaced, Hispano-Suiza maintains, by guidance sophistication developed for other tactical maneuvers. ⌗

U.S., British Join in New Radio Satellite Test Work

THE U.S. AND BRITAIN will cooperate in further tests of radio communication by satellite.

An agreement by the British Post Office, the National Aeronautics and Space Administration and the American Telephone and Telegraph Co. calls for U.S. launching of a satellite next year to transmit speech and television from Rumford, Maine, to a receiving station being built by the British at Goonhilly Downs, The Lizard, Cornwall.

The test program, named TSX, will study the possibility of using satellites for continuous 24-hour phone and telegraph service, and worldwide coverage in combination with existing radio and cable links. The satellites, which might carry 1000 telephone channels and one or two TV channels, would use higher frequency bands than the *Relay* satellite.

The test satellite will be controlled from the U.S. ⌗

names in the news

TAYLOR

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Dr. J. A. Rajchman: Pioneer in computer research, appointed director, Computer Research Laboratory, Radio Corporation of America's David Sarnoff Research Center, Princeton, N.J. Other RCA appointments are: **Charles A. Daly, Jr.,** manager, Small Business Affairs; **Edwin S. McCollister,** division vice president, Marketing, Electronic Data Processing; and **James Lee Owings,** manager, Engineering, Data Communications and Customs Projects Dept., Electronic Data Processing Division.

George C. Dacey: Director of Solid State Electronics Research, Bell Telephone Laboratories, will become vice president-research, Sandia Corp., Albuquerque, N.M., on Oct. 16. Dacey succeeds **Calvin F. Quate,** who has accepted the position of Professor of Applied Physics and Electrical Engineering, Stanford University.

Sidney Thurston: Veteran marine propulsion engineer, named manager of Hydropower Div., Astropower, Inc., Costa Mesa, Calif., a subsidiary of Douglas Aircraft Co.

Philip B. Taylor: Former Assistant Secretary of the Air Force for Materiel, elected to the board of directors, General Precision Equipment Corp., Tarrytown, N.Y. **George T. Mundorff** appointed administrative assistant to **R. E. Hastings,** Librascope Div. vice president and manager of General Precision's Burbank, Calif., branch. Mundorff transferred to Librascope from GP headquarters, where he was manager of corporate systems and procedures.

Dr. Bernard Friedland: Appointed senior staff consultant, and **Steven M. Sussman,** head of Communications Theory Laboratory, Melpar's Applied Science Div., Watertown, Mass.

Dr. Bernard Wambsganss: Appointed assistant to president, Alfred Electronics Corp., Palo Alto, Calif. Before joining Alfred, Dr. Wambsganss was chief scientist of the Office of Naval Research Branch Office, San Francisco, and also with Sylvania Electronics Defense Laboratories.

Clifford E. Willis: Appointed vice president of operations, Avien, Inc., Woodside, N.Y.

Lawrence Weeks: Former engineering manager, McDonnell Aircraft Corp., joins Aerospace Corp., Los Angeles. **C. Ray Porter** named manager of Aerospace Corp.'s New England Office, Lexington, Mass.

Melvin J. Albom: Formerly with Aerojet-General Corp. and Reaction Motors, Inc., joins The Marquardt Corp. as chief metallurgist at the Van Nuys, Calif., plant.

C. R. Possell: Named chief engineer, Assembly Engineers, Inc., Los Angeles. Formerly Possell was president and chief engineer, Propulsion Development Laboratories.

Capt. Joseph Garrett, USN: Former Air Warfare Officer, Office of Naval Research, Washington, D.C., and Plans Coordination Officer, Pacific Missile Range, assigned to PMR headquarters as Range Operations Officer. Capt. Garrett relieves **Capt. Frank L. DeLorenzo, USN,** who assumes command of the USS Kennebec in the Atlantic Fleet.

Dr. Charles M. Herzfeld: Appointed associate director, National Bureau of Standards, Washington, D.C. With the Bureau since 1955, he will continue as Acting Chief of the Heat Division until a new chief is appointed.

Edward Bishop, Jr., Treasurer; **H. Kenneth Hudson,** general sales manager, Military Div.; **William F. Frankart,** director of engineering; **John C. Mathews,** director of purchasing; and **Frederick Trowbridge,** director of quality control; elected vice presidents, The Hallicrafters Co., Chicago.

Calvin A. Gongwer: With Aerojet-General since 1945 and manager of its Oceanics Div., named vice president, Special Projects, Global Marine Exploration Co., in which Aerojet recently purchased a 45% interest with a view of expanding its oceanic activities and exploration. Gongwer participated in the development of the Alclo solid propellant, the invention of the Hydrocket, and is a co-inventor of the MiniSub.

Dr. James A. R. Samson: Research physicist who recently established a vacuum ultraviolet laboratory at Harvard University to develop satellite spectrometers for solar ultraviolet research, joins the staff of the Geophysics Corp. of America, Bedford, Mass.

Alfred J. Pote: Former vice president, Itek Corp., elected senior vice president and assistant to the president, Page Communications Engineers, Inc., a subsidiary of Northrop Corp., Washington, D.C.

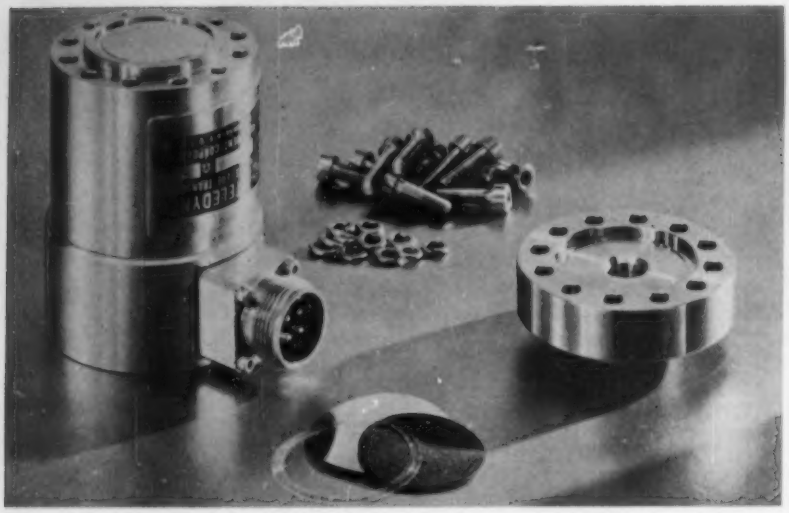
Dr. Alfred Schneider: Joins The Martin Co., Baltimore, as manager of fuel development; **Justin L. Bloom,** named manager of process development and **Meyer Pobereskin,** manager of isotope production. All are new positions in the Nuclear Chemistry Dept. in support of the company's program to step up development of fuels for SNAP atomic generators.

Dr. Earl W. Lindveit: Former staff member of the U.S. Senate Space Committee, appointed Washington representative for the Defense Systems Division of General Motors Corp. Dr. Lindveit is the author of the U.S. Senate reports on Project *Mercury* and "Space Research in the Life Sciences" and the book "Scientists in Government" published last year.

Walter J. Schafer: Former manager of space vehicle engineering, Missile and Space Vehicle Dept., General Electric Co., appointed director of engineering, Aircraft-Missiles Div., Fairchild Stratos Corp., Hagerstown, Md.

Roy C. Ingersoll: Retires as chairman of the board, Borg-Warner Corp., Chicago, on Sept. 30, bringing to a close an active business career of more than 53 years. He will be honorary chairman of the board and also continue as a director. **Robert S. Ingersoll,** president of Borg-Warner, elected chairman of the board and chief executive officer, effective Oct. 1. **Lester G. Porter,** now executive vice president, named to succeed Robert S. Ingersoll as president on the same date.

products and processes



New Product of the Week: Taber's Transducer

An easily-maintained rapid-response pressure transducer is now available from Taber Instrument Corporation. A newly improved version of its Teledyne Model 176, the 3-lb. instrument has pressure ranges from 0-300 to 0-10,000 psig and may be operated continuously in the temperature range of −65° to 250°F.

Its high-frequency response, says Taber, makes it unusually suitable for measuring dynamic pressures encountered in the testing of rocket, jet, or turbine engines; hydraulic systems; and high-speed chemical reactions.

A stainless-steel cavity, diaphragm, and seal permit measurement of highly caustic liquids and provide positive protection for the electrical measuring element from the media in the cavity.

Four precision strain gages, bonded to the inner and outer circumferences of a positive proving ring, comprise the measuring element. Linearity deviation of output signals, says Taber, is less than 0.25% of full scale from a standard straight-line function determined by Least Squares Method. Units may be used with either a constant-voltage or constant-current system.

Circle No. 225 on Subscriber Service Card

Frictionless Motors

A motor which will run indefinitely, never needs oiling, can spin 5000 times in the flick of an eyelid, and works equally well in extreme low and high temperatures will be available from IMC Magnetics Corp.

The motor's secret lies in its air bearings—the surfaces on which the motor shaft rotates. Pressurized air cushions the shaft and allows it to spin with almost no friction. Air-bearing motors can operate at temperatures where the oil in conventional motors would freeze or burn up.

Circle No. 226 on Subscriber Service Card

Axial Lead Power Resistor

Ward Leonard Electric Co. is marketing four additions to its Axiohm power-resistor line engineered for automation, printed circuits and advanced miniaturization use.

These miniature power resistors are intended for electronic applications where high stability coupled with high overload capacity of vitreous enamel wire-wound power resistors is essential to reliable performance.

The new 2, 4, 7 and 12.5 watt resistors plus the former 3, 5 and 10 watt units make seven sizes available to electronic design engineers. Watt ratings for all sizes are based on a 325°C rise, 25°C ambient. Design changes also have been made in the 5- and 10-watt units, reducing their size by approximately 25%.

Circle No. 227 on Subscriber Service Card

Silicon RF Mixer Diodes

Eighty high-reliability silicon RF mixer diodes for extremely low-noise mixer performance through 10,000 mc are available in two cartridge case types from Microwave Associates, Inc.

The fixed base cartridge series (MA-449B through MA-449F) directly replaces EIA types IN21B through IN21F. Reversed polarity diodes, MA-449BR through MA-449FR are also available. The reversible polarity equivalent types in double-ended cartridge with detachable base adapter (MA-459B through MA-459F) directly replace EIA types IN416B through IN416F.

The calculated overall noise figure for the MA-449F and MA-459F is 6.0 db (max.) for 30 mc IF noise of 1.5 db. The new types are designed for 150°C operation and are hermetically sealed, using an exclusive metal-to-ceramic solder-seal and solder-end seal construction for highest reliability. They pass applicable military environmental specifications MIL-S-19500.

Circle No. 228 on Subscriber Service Card

Cryogenic Thermometer

Radiation Research Corp. is producing a cryogenic thermometer type CG-1 for use in the accurate measurement of temperatures in the liquid helium range of 1.5 to 5.0°K.

The subminiature hermetically sealed units, less than 0.350 in. long by 0.130 in. diameter, weigh less than 0.5 g

each and can be easily located in the most difficult and inaccessible spots for more accurate temperature measurement than is attainable by any other means commercially available for the indicated use range.

The type CG-1 thermometer now has accuracy and repeatability of considerably better than ±0.050°K; improvement to ±0.001°K is expected.

Circle No. 229 on Subscriber Service Card

Low-Cost Ohmmeter

The NLS 784 precision digital ohmmeter with printout connection has been introduced by Non-Linear Systems, Inc. The 784 has been designed for accuracy, reliability and simplicity of operation. It is fully automatic, with automatic range changing, positioning of the decimal point, and built-in controls for automatic operation of data printers. For trouble-shooting and servicing ease, the NLS 784 features NLS plug-in stepping switches, decade resistors mounted on plug-in circuit boards, and a snap-out readout to permit changing readout lamps in less than one minute.

Circle No. 230 on Subscriber Service Card

Sweep Generator

A sweep-signal generator with changeable plug-in type oscillators covering frequency ranges of audio to 3000 mc is available from Telonic Industries Inc. Designated Telonic Model MS-2000, the generator accepts any of 19

different Telonic oscillator heads.

Construction is of the mil-slotted type, allowing quick, convenient range-changing with only one basic instrument. The various plus-in heads available include the E series with outputs covering the higher frequencies from 500 to 3000 mc, the S series for mid-range, 5 to 1200 mc, the L series for the lower frequencies from 10 kc to 275 mc, and the A series covering the audio frequencies.

Circle No. 231 on Subscriber Service Card

Single-Sideband Strip Receiver

The Hallicrafters Co. has available an integrated multi-channel, single-sideband (SSB) communications system for the high-frequency spectrum that makes the full advantages of SSB operation readily available for commercial and military applications—stationary, vehicular, airborne or shipboard. Compared to AM systems, the Hallicrafters 116 series of SSB equipment offers a 2-to-1 advantage in spectrum utilization with greater frequency stability, requires 12 to 16 db less radiated power for equal performance, is far less affected by selective fading and phase distortion and, having only half the bandwidth, is less subject to narrow-band man-made interference.

Circle No. 232 on Subscriber Service Card

Tuning-Fork Standard

Miniature tuning-fork frequency standards, which at audio frequencies approach the precision and stability of crystal oscillators, are available from Special Products Div. of Melpar. Inc.

The frequency standard is a transistorized electro-mechanical oscillator designed for systems which require a precise audio frequency sine wave or square wave for reference, measurements, time bases, and marker or clock pulses.

This design, which Melpar considers revolutionary, consists of the tuning fork and associated amplifier-oscillator printed circuit board, both enclosed in a small hermetically sealed evacuated case (MIL-T-27 Type AH) 1-17/64 x 1-17/64 x 1-3/4 in., weighing less than 2.9 oz.

Circle No. 233 on Subscriber Service Card

Photoconductive Cell

A miniature photoconductive cell which approximates the spectral perception of the human eye more closely than any other device is available from Clairex Corp. This cadmium-sulphide cell can measure either tungsten or daylight over a wide range of color temperatures through variation in its conductance. The I series will contain six distinct types designed for both normal and low-impedance transistor type applications in both side- and end-view hermetically sealed configurations.

Circle No. 234 on Subscriber Service Card

D-c/D-c Converters

A line of miniature, high-voltage, plug-in converters—especially designed for use in or with nucleonic instruments, photo multipliers, cathode ray tubes, and high-altitude research instruments—has been introduced by Universal Transistor Products Corp. Eleven models in four series are immediately available from stock, offering a wide range of input-output voltage combinations, adjustable or regulated. Outputs range from 500v to 5000 d-c, with inputs varying from 1.25v to 28v d-c.

Circle No. 235 on Subscriber Service Card

41 years' experience in building and operating global communication networks (serving 99 countries) gives RCA unique capabilities in space-age communications. Talk with us if your responsibility includes the development of international communication systems between command and satellite tracking stations.
Write or telephone RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4, Tel. HAnover 2-1811, Area Code 212.
RCA The Most Trusted Name in Communications

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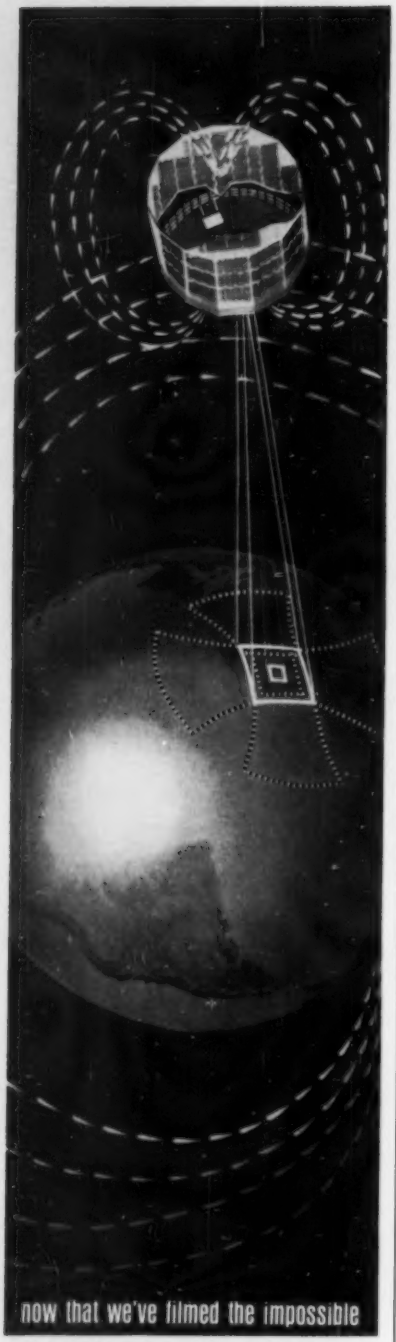

what can we do for you?

We had the answer for TIROS...for NIMBUS. We've had the answer to movie camera, still camera, X-ray camera and aerial camera problems. We've had the answer to problems of high volume-low unit costs; we've had the answer to problems where few-of-a-kind are involved. If your company is facing an optical design problem, Elgeet's engineering and design section welcomes the challenge to create the breakthrough that you require.

Write: Elgeet Optical Company, 838 Smith St., Rochester, N.Y.

Elgeet

EL-63

contracts

NASA

$419,885—J. W. Fecker Div., American Optical Co., Pittsburgh, Pa., for production of vacuum chamber and optical bench with an ultraviolet monochrometer for Goddard Space Flight Center.

Dunn Engineering Corp., Cambridge, Mass., for an advanced air-bearing turn-table to evaluate the equipment that will guide the *Saturn* rocket through space. No amount disclosed.

National Research Corp., Cambridge, Mass., for a preliminary study of propellant feed systems for spacecraft ion engines. No amount disclosed.

MISCELLANEOUS

$5,000,000—Bendix Corp., N. Hollywood, Calif., from **Sikorsky Aircraft Div., United Aircraft Corp.,** for helicopter-borne sonar systems.

$3,000,000—FXR Div., Amphenol-Borg Electronics Corp., Broadview, Ill., from **Sperry Gyroscope Co.,** for shipborne radar transmitters for use in Mobile Atlantic Range Stations (MARS) missile tracking program.

$1,077,404—J. W. Fecker Div., American Optical Co., from **Sperry Co.'s Marine Div.,** for development of two tracking optical telescopes for MARS.

$211,500—General Electric's TEMPO, Santa Barbara, Calif., from Defense Atomic Support Agency, for establishment of an information center on the subject of high-altitude nuclear effects for use of government, industrial, and academic research workers.

The Siegler Corp., Los Angeles, from **North American Aviation,** for manufacture of hydrogen-peroxide fuel containers for the *X-15* program. No amount disclosed.

NAVY

$59,100,000—General Dynamics/Pomona, Calif., for continued production of advanced *Terrier* and *Tartar* guided missiles. (Includes funds for operational spare parts for logistic support.)

$16,103,259—Martin Co., Orlando, Fla., for *Bullpup* missiles.

$10,845,000—Bendix Corp., Mishawaka, Ind., for first-phase development of new long-range shipboard *Typhon* antimissile missile.

$9,223,331—Goodyear Aircraft Corp., Akron, Ohio, for *Subroc* missiles.

$1,000,000—Radio Corporation of America Laboratories, Princeton, N.J., for *Polaris* command communications systems.

$585,000—Vitro Laboratories, div. of Vitro Corporation of America, Silver Spring, Md., from BuWeps, for continuation of engineering services on torpedo system.

$506,861—IBM's Federal Systems Div., Rockville, Md., for development of a high-volume production system for continuous manufacture of ultra-reliable thin-film subassemblies.

$210,444—Capehart Corp., Richmond Hill, N.Y., for production of twelve AN/SPS-10 surface radar systems.

ARMY

$3,257,552—Raytheon Co., Waltham, Mass., for production of electronic components for *Hawk* missile system (subcontracted to Varian Associates, Palo Alto, Calif.)

$1,556,831—Emerson Electric Co., St. Louis, for continued production of components and containers for *Honest John* rocket.

$1,102,890—Aerojet-General Corp., Downey, Calif., for XAE drone development program.

$34,833—Dr. A. R. C. Westwood, scientist at Research Institute for Advanced Study, The Martin Co., Baltimore, for study of effect of surface coatings on the behavior of metals.

Vernitron Corp., Carle Place, N.Y., from **General Dynamics/Pomona,** for development of a booster-less resolver chain for the **Mauler** missile system. No amount disclosed.

AIR FORCE

$14,650,000—RCA Service Co., Camden, N.J., for operation and maintenance services for White Alice communications system.

$215,000—Communication and Data Systems Div., Collins Radio Co., Dallas, for high-speed data-transmission equipment for Atlantic Missile Range.

$175,000—Delco Radio Div., General Motors Corp., Kokomo, Ind., from **The Boeing Co.,** for transistors for *Minuteman* ICBM program.

$137,000—Univac, St. Paul, Minn., for preparation of computer guidance programs for a series of five NASA satellite launchings in 1962.

$80,000—Electro Mechanical Research, Inc., Sarasota, Fla., for a telemetry data conversion system for installation in Air Proving Ground Center's Mathematical Services Laboratory, Eglin AFB, Fla.

Bell Aerosystems Co., Buffalo, N.Y., for a stability, control and performance study of experimental man-carrying rocket belt developed by Bell.

Optics Technology, Inc., Belmont, Calif., for research and development in the field of infrared fiber optics. No amount disclosed.

Packard Bell Computer Corp., div. of Packard Bell Electronics, Los Angeles, for production of two micrometeorological data systems; one for Cape Canaveral, the other for Vandenberg AFB. No amount disclosed.

REQUESTS

Proposals have been invited for a Nuclear Detection and Reporting System (System 477L-NUDETS) by the Electronics Systems Division of the Air Force Systems Command, Hanscom Field, Mass.

This system will be designed to automatically detect any nuclear explosion on the North American continent and report information on the blast to the North American Air Defense Command (NORAD) Headquarters in Colorado and to other government agencies.

The following firms have been invited to participate: Aerojet-General Corp.; Airborne Instruments Laboratory; Alpha Corp. (Collins Radio); American Machine & Foundry Co.; Autonetics Div., North American Aviation, Inc.; Beckman Systems Div.; Bell Aerosystems Co.; Bendix Corp.; Burroughs Corp.; Convair; Cook Research Laboratories; Edgerton, Germeshausen & Grier, Inc.; Electronic Communications, Inc.; Fairchild Electronic Systems Div.; General Electric Co.; General Precision, Inc.; Hughes Aircraft Co.; International Telephone and Telegraph Corp.; Ling-Temco Electronics, Inc.; Lockheed Aircraft Corp.; The Martin Co.; McDonnell Aircraft Corp.; Motorola, Inc.; National Electronics Facilities Organization, Inc.; Philco; Radio Corp. of America; Raytheon Co.; Republic Aviation Corp.; Sperry Gyroscope Co.; Sylvania Electronic Systems; The Ralph M. Parson Co.; Thompson Ramo Wooldridge, Inc.; United Aircraft Corp.; United ElectroDynamics, Inc.; Western Union Telegraph Co.; Westinghouse Electric Corp.

The proposals, scheduled to be received by September 29, will lead to a development contract for a prototype 477L System.

Small business firms and others interested in subcontracting opportunities should make direct contact with the above firms.

Circle No. 13 on Subscriber Service Card

LETTERS

(Continued from page 7)

The first meeting was in May; in June we chartered with 65 members; we now have 95 members. The Mayor of Atlanta and the Governor of Georgia signed a proclamation establishing the week of Sept. 10-16 as Women in Construction Week.

In the short time that the Atlanta chapter has been organized, we have accomplished much. This is typical not only of our work in this organization but of the work that we do within the industry.

As my boss tells me, it is time that the females get a little recognition for the part they are playing in our expanding industry.

Ruth Rubin (Mrs. Monte Rubin)
Publicity Committee
Women in Construction
Atlanta

Thanks from Sweden

To the Editor:

I have reviewed your World Missile/Space Encyclopedia (M/R, July 17) and find this information very useful and interesting.

Thank you for a fine publication.

Fritz Tingstrom
Stockholm
Sweden

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Frankfurt/Main, West Germany—Friedrich-Ebert-Anlage 3

ECM Break Through

(Continued from page 34)

line is a given 90° quadrant. Multiple signals at different frequencies are displayed as many lines in the quadrant, each one at an angle that is uniquely a function of its frequency.

Frequency modulated signals are displayed as a solid angle—or a thickening of the line if the frequency deviation is low.

Other displays, or storage of the frequency information may also be used with the discriminator with an attendant increase in circuit complexity.

The frequency resolution in S-band compares favorably with a channelized receiver utilizing 80 filter sections and as many detectors and video amplifiers.

Absolute frequency indication is independent of incoming power level, as long as the "law" of the video detectors does not change. This suggests the use of a broadband limiter ahead of the discriminator if large signal environments are expected. Manually operated r-f attenuators may also be used to examine an occasional large signal.

• **Other uses**—Application of the WHIP principles, in addition to receivers, are in laboratory test equipment and ground checkout equipment use where quick frequency determination can be made. The light weight and low power consumption inherent in this type of receiver are particularly attractive in situations where frequency determinations are to be made in the uhf and microwave spectrum and these parameters are of prime importance.

Using the system for ECM applications, radio or radar frequencies can be identified readily. The WHIP receiver system can also make calibrations of amplitude and approximate r-f power measurements.

In electronic warfare, the WHIP receiver will function as a wideopen alarm, telling where to tune conventional narrow-band scanning superhetrodyne or trf receivers and jammers.

Its low cost and size should prove it adaptable to so-called "expendable jamming." Here, small missiles or rockets with jamming transmitters for warheads are used to provide an "electronic cover" for advancing troops, the receiver detecting enemy communication frequencies.

In the laboratory, the WHIP receiver fills the need for a simple, low-cost wideband frequency detector for rfi studies. ⌗

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Agency—Batten, Barton, Durstine & Osborn, Inc.

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Agency—Sy Rosen Adv., Inc.

Wayne/George Corp. 10
Agency—Meissner & Co., Inc.

editorial . . .

A Spotlight for Rover

THE SCHEDULE in the *Rover* program calls for test flight of a nuclear rocket engine by 1965. Use of these engines may make possible direct manned flights to the moon by the 1967 target date.

Importance of the *Rover* program to U.S. efforts to beat the Russians to the moon is, therefore, evident. All of the big *Saturn* and *Nova* boosters are to be designed so they can lift nuclear upper stages.

The program deserves highest priority.

Yet, as associate editor Frank McGuire points out in our lead article this week, the *Rover* program is running into the same snarls which tied the equally-important *Atlas* and *Titan* ICBM programs into knots.

Just as with the much-publicized missile base delays, the difficulty centers around construction. Contractors are trying to save money; labor unions are walking off the job; management is too powerless or too inept to do anything about it; contracting procedures force the letting of contracts to unqualified bidders.

The whole mess has such a familiar ring to it that it sounds like the nightmare on missile base construction all over again. But there is a big difference. The ICBM programs were military. Once the truth about the ICBM base delays became evident, the Air Force and Army Corps of Engineers moved swiftly to remedy the situation.

No such sense of urgency is evident in the current situation.

Look at the slippage in testing the reactors which are leading to a flight engine. Some observers believe Kiwi A actually could have been tested a year earlier than it was, although AEC officials are inclined to dispute this. Kiwi A-Prime was delayed six months. Kiwi B 1A already is four to five months behind schedule. There is a possibility it may not meet its new target date next month.

Greedy contractors and irresponsible labor unions are not entirely to blame for the situation, by any means. Equipment vital to the test cells is delivered late by the manufacturers, forcing contractors to lay off help while marking time. Specifications are changed; then changed again—and again.

It is not news that the *Rover* program is having administrative difficulty. That was evident some time ago and at least two Congressional committees have taken a look at the program for that reason. It is news that so little is being done about it.

The House Space Committee recommended some months ago that management of the program be overhauled to give more authority to the joint NASA-Atomic Energy Commission Space Nuclear Propulsion Office headed by Harold B. Finger.

It asserted in a staff report that the office should have "sufficient authority effectively to direct the progress" of *Rover* and that the funding level of the Nevada facilities should be restudied. Purpose of the latter recommendation was to assure that adequate support and test facilities will be ready when needed.

We have seen no indication that these recommendations are being implemented. NASA Administrator James E. Webb indicated recently that a step-up in the program is under consideration. This would mean early naming of a contractor for the nuclear rocket engine, an action not expected under present schedules before 1962.

But early contractor selection, while welcome, would not in itself be sufficient. In view of the continuing delays in the program, its management should come under close scrutiny. If more authority is needed before a proper job can be done, it should be provided. If the management already has the necessary authority and is too ineffective to use it, the management should be changed.

This program is too important to the nation to be allowed to slip further into the same sordid morass that bogged down the ICBM programs in their later stages. We should profit from that lesson. The time to save the *Rover* project is right now, not farther down the line.

The Senate's Permanent Investigating Subcommittee did a good job in its investigation of the difficulties which delayed construction of U.S. missile bases. It is cognizant of the labor practices and the management problems which plagued those projects.

Disclosures before the McClellan subcommittee did much to jar both the Department of Defense and the Kennedy Administration into action. The National Missiles Sites Labor Relations Committee, set up under Labor Secretary Goldberg, was given sufficient power to clean up the situation, as witnessed by settlement of the wildcat walkout at *Titan* sites near Denver just last week.

IF THE McCLELLAN Subcommittee was instrumental in bringing the facts to light on the ICBM programs, it might very well be worthwhile for the same committee to take a look at the *Rover* program.

As one of the officials interviewed by Mr. McGuire said: "There is nothing to distinguish this program in importance from our ICBM base-activation program except that the missiles are a bit closer in urgency. We will be staking our lives in a few years on nuclear rockets because of what they can do, and there is no time for sabotage-by-neglect to be allowed such a stranglehold on the program."

A public spotlight would do much to clean up the mess.

William J. Coughlin

MARTIN NUCLEAR ROCKET PROGRAM

- REACTOR DESIGN
- PROPULSION REACTOR START-UP
- NUCLEAR ROCKET SAFETY ANALYSIS
- RADIATION EFFECTS ON ROCKET SYSTEM
- FUEL ELEMENT DEVELOPMENT
- VEHICLE DESIGN
- CRYOGENICS

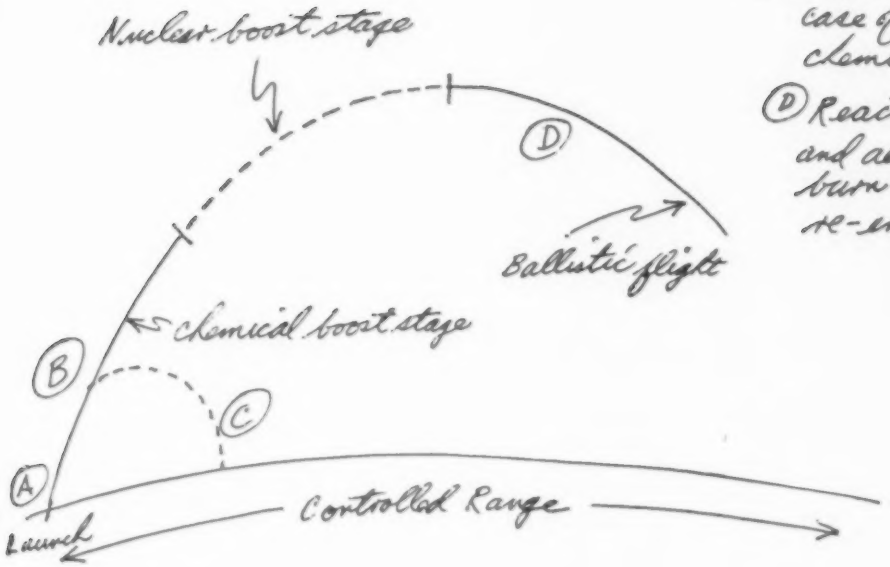
Safety Requirements

(A) Safe disposition of reactor in case of launch pad abort

(B) Rapid reactor start-up without risk of a nuclear excursion

(C) Safe disposition in case of abort during chemical boost

(D) Reactor fragmentation and aerodynamic burn-up during re-entry



SAFETY ASPECTS OF NUCLEAR ROCKET FLIGHT TESTING

Safety is one of the many areas receiving continuous attention in the U. S. nuclear rocket program. Tests must be conducted to obtain data, to develop safety systems, and to demonstrate safety.

During the past several years, Martin has gained valuable experience in the safety field through its investigations and tests concerning the use of radioisotope-fueled generators for auxiliary power in space. Analytical investigations of nuclear rocket safety conducted by the company under the RIFT (Reactor in Flight Test) program for the National Aeronautics and Space Administration are being continued. The U. S. Atomic Energy Commission's SNAP program, under which The Martin Company developed the radioisotope-fueled generator that powers two radio transmitters in a Transit satellite, involved exhaustive safety studies and tests. This was the first use of atomic energy in a space vehicle. Experience in computer analysis of booster behavior, flight test of large boosters (VIKING, VANGUARD, TITAN and PERSHING) at Cape Canaveral, re-entry, system integration, missile test range control and rocket destruct systems, as well as extensive experience in nuclear technology, has been invaluable in the development of technical capabilities and facilities required for these investigations.

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